A350
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSE - T1+T2 - RR Trent XWB
Standard Practices and Structures

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STANDARD PRACTICES AND STRUCTURES

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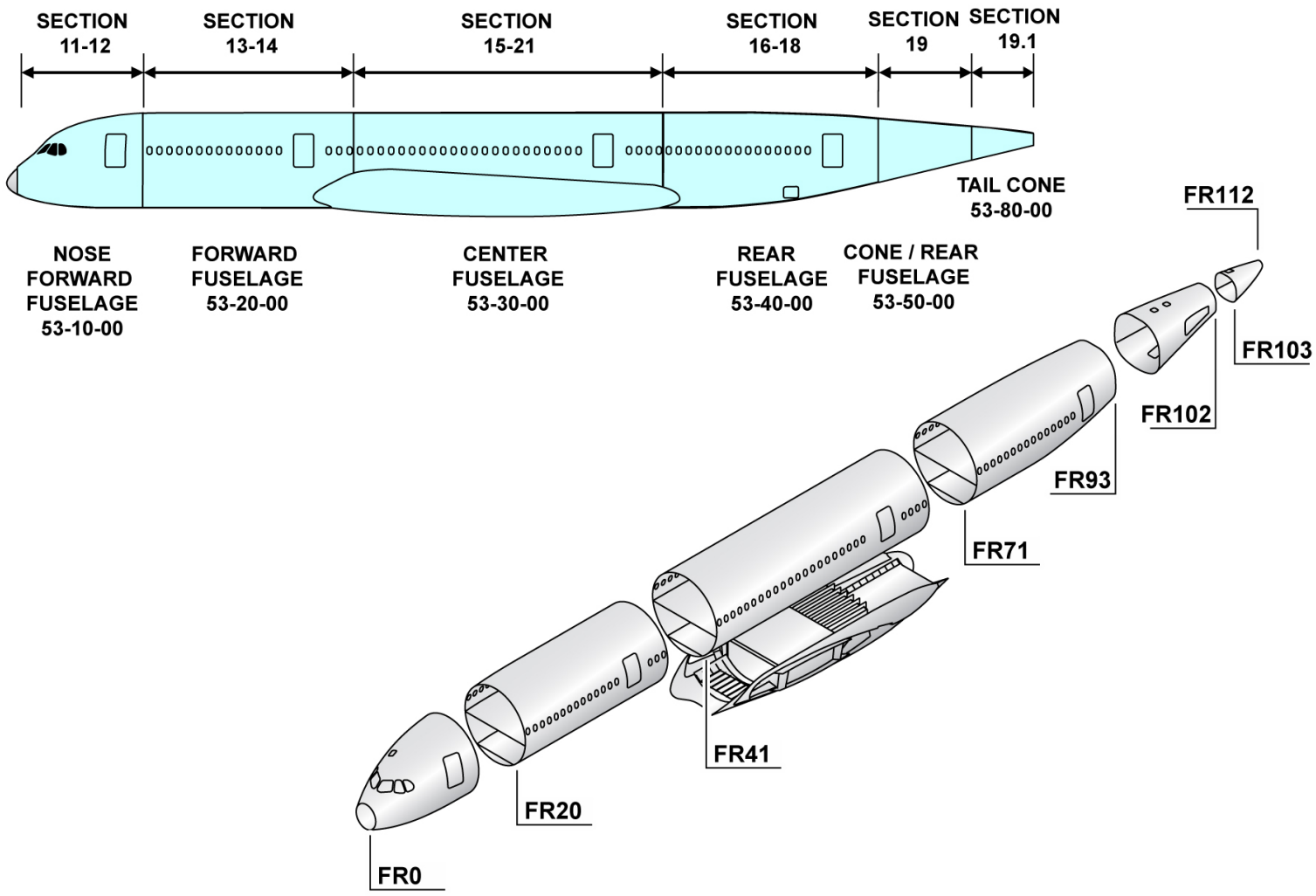
V2414251 - V00T0MM0

FUSELAGE DESCRIPTION (3)

General Arrangement

The fuselage is divided into six primary parts:
- Nose forward fuselage (section 11 and section 12, from FR0 to FR20)
- Forward fuselage (section 13 and section 14, from FR20 to FR41)
- Center fuselage (section 15, from FR41 to FR71)
- Rear fuselage (sections 16 and section 18, from FR71 to FR93)
- Cone/rear fuselage (section 19, from FR93 to FR102)
- Tail cone (section 19.1, FR103 to rear fairing).

V2414251 - V00T0MM0 - VM51D1FUSEL3001



GENERAL ARRANGEMENT

V2414251 - V00T0MM0 - VM51D1FUSEL3001

FUSELAGE DESCRIPTION (3)

General Fuselage Structure

The two design types are the metallic and composite design.
The metallic design uses aluminum, titanium, steel and their alloys, depending on the component location and function.
The composite design is divided in two categories: Monolithic (solid blocks) and the sandwich. The types of material can be carbon, quartz, glass or other type of fibers depending on the component location and function.

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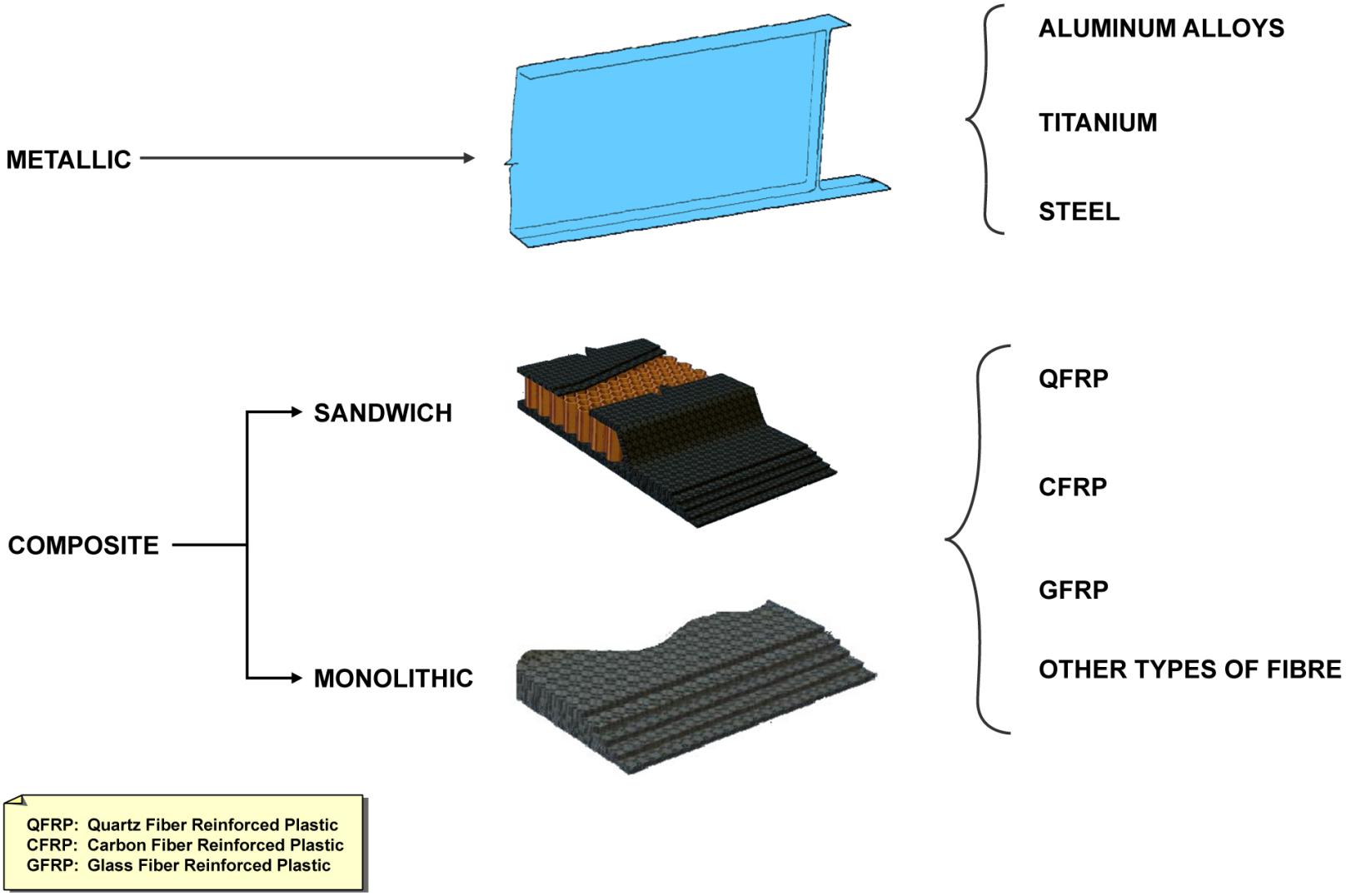

GENERAL FUSELAGE STRUCTURE

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FUSELAGE DESCRIPTION (3)

Panel Concept

The forward, center and rear fuselage sections are made of four shells/panels per section.

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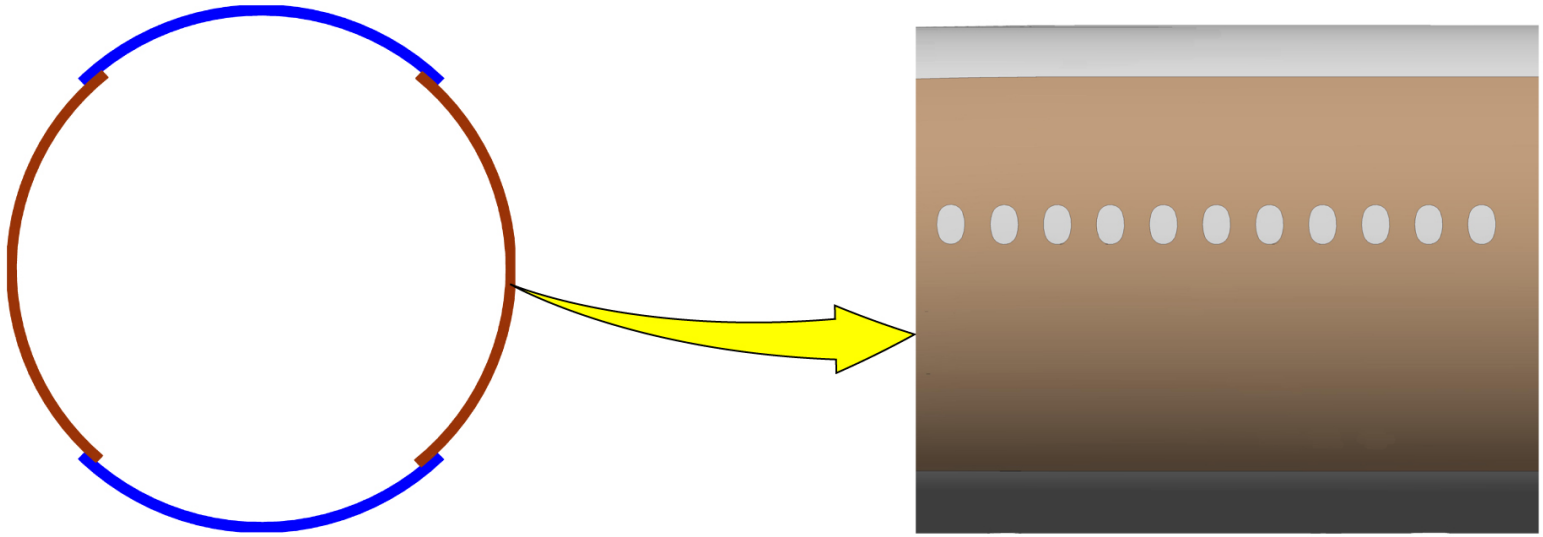

PANEL CONCEPT

FUSELAGE DESCRIPTION (3)

Panel Concept (continued)

Skin, Frame and Stringer Concept

The aircraft structure includes the frame assembly, stringers (an omega shaped), cleat and skin.

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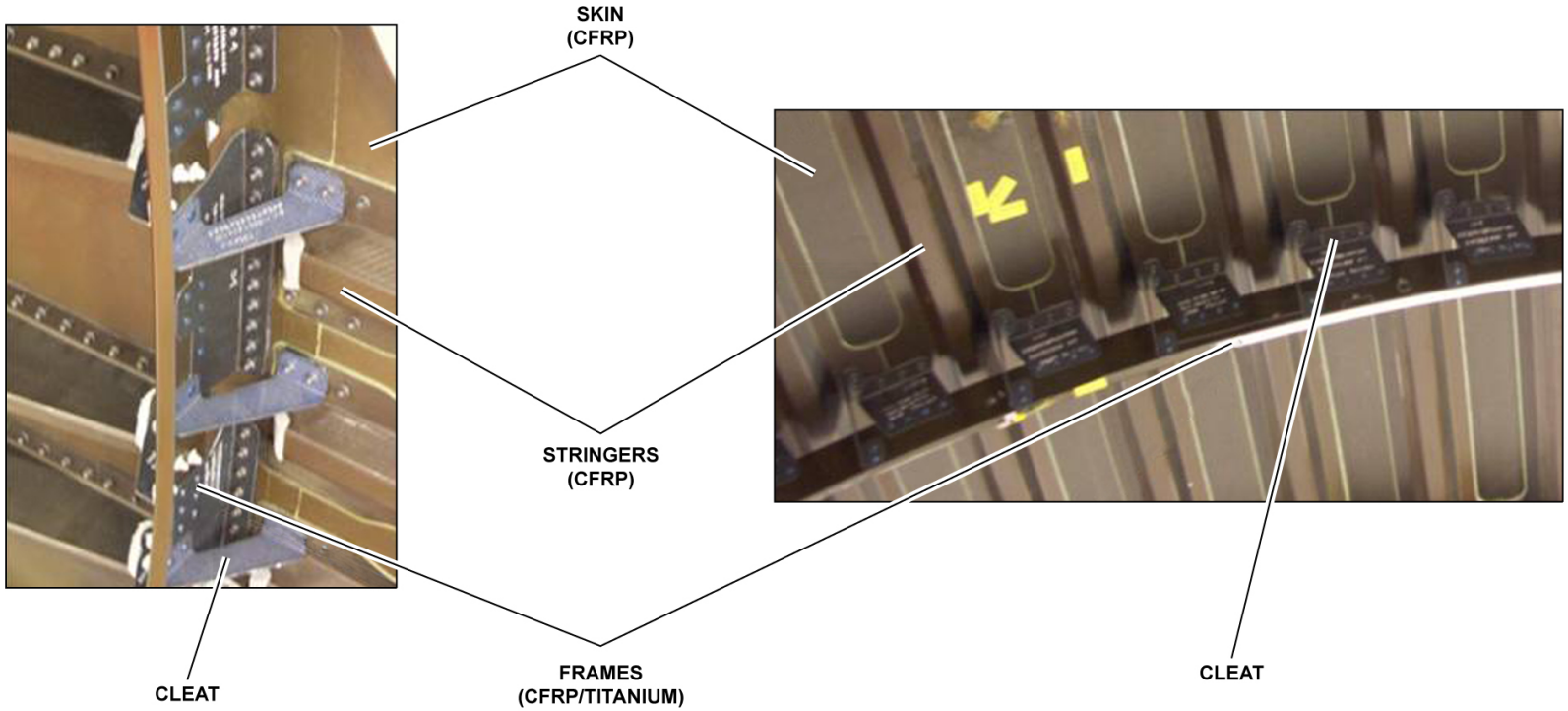

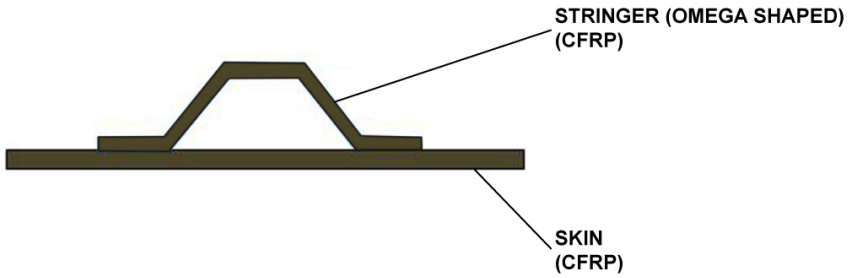

PANEL CONCEPT - SKIN, FRAME AND STRINGER CONCEPT

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FUSELAGE DESCRIPTION (3)

Panel Concept (continued)

Typical Fuselage Structure

The structure is made of skin panels (Carbon Fiber Reinforced Plastic (CFRP)), frames (CFRP or titanium) and stringers (CFRP). The cabin floor structure has floor panels (sandwich CFRP), supported by seat rails (aluminum or titanium) and crossbeams (aluminum-lithium). Struts (aluminum-lithium) give support to the cabin floor structure and are attached to the crossbeams and to the aircraft frames.
The floor structure of the cargo compartment has crossbeams (aluminum-lithium). Crossbeams are attached to the aircraft frames. Struts (CFRP) give support to the crossbeams. The roller tracks are attached to the crossbeams.

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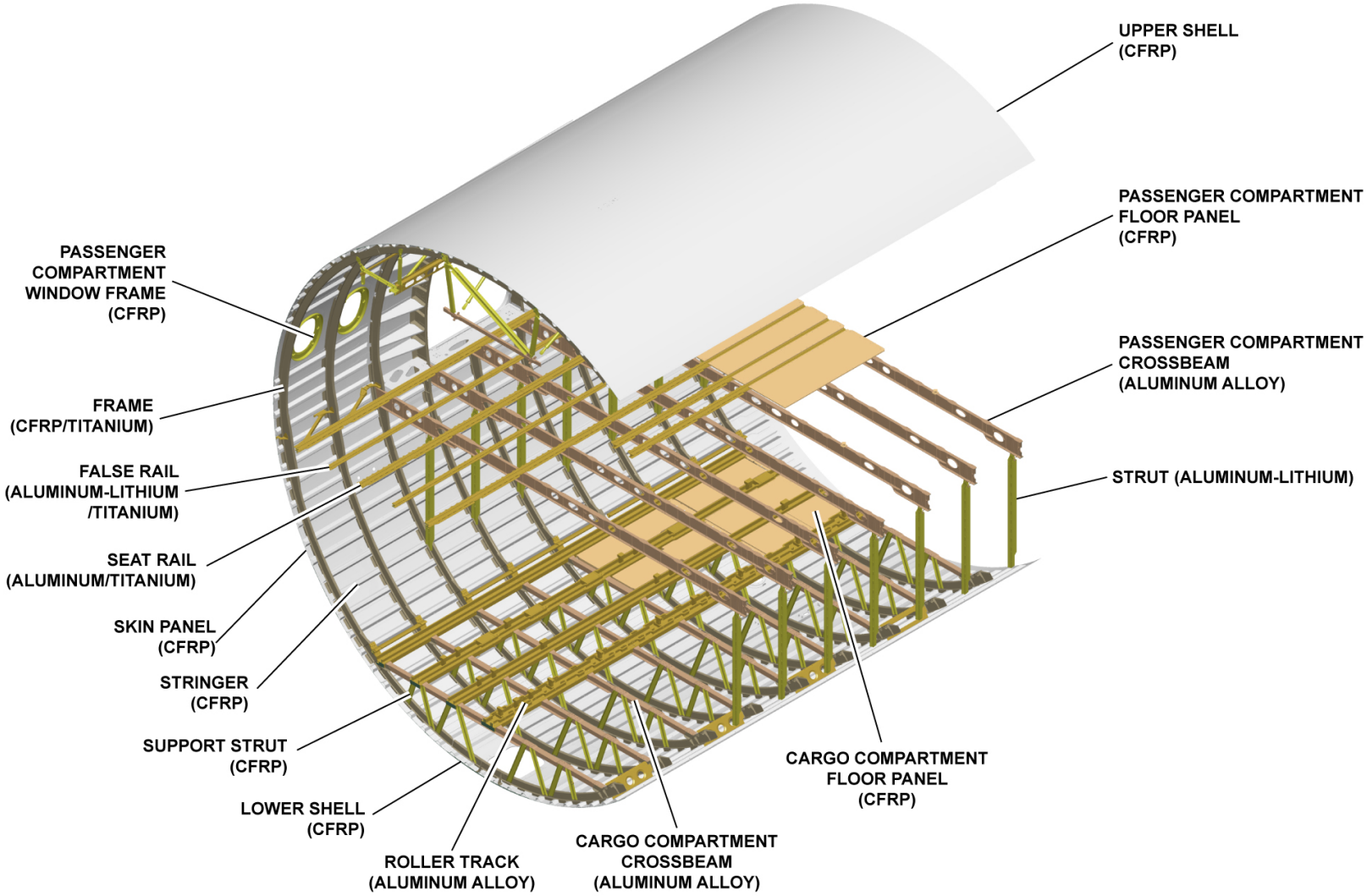

PANEL CONCEPT - TYPICAL FUSELAGE STRUCTURE

V2414251 - V00T0MM0 - VM51D1FUSEL3001

FUSELAGE DESCRIPTION (3)

Nose Forward Fuselage

Nose Upper Unit

The nose upper unit has these components:
- Skin panels
- Frames and stringers
- The PAX floor
- Two PAX/crew doors.

All these components are made of different materials (aluminum alloys, titanium and CFRP).

Nose Lower Unit

The nose lower unit gives access to an avionics compartment. The internal structure gives support to all the electrical equipments and the electronic racks.
The nose lower unit has these components:
- Skin panels
- Frames and stringers
- The pressure bulkhead with the Nose Landing Gear (NLG) bay
- An avionics-compartment floor structure and access door
- A forward jacking adapter.

All these components are made of different materials (aluminum alloys, titanium and CFRP).

Radome

The radome (made of Quartz Fiber Reinforced Plastic (QFRP) and aramid) gives protection to the radar antenna. It gives an aerodynamic fairing structure to the nose fuselage. The radome has lightning and rain erosion protection. The radome has quick-release latches and hinges.

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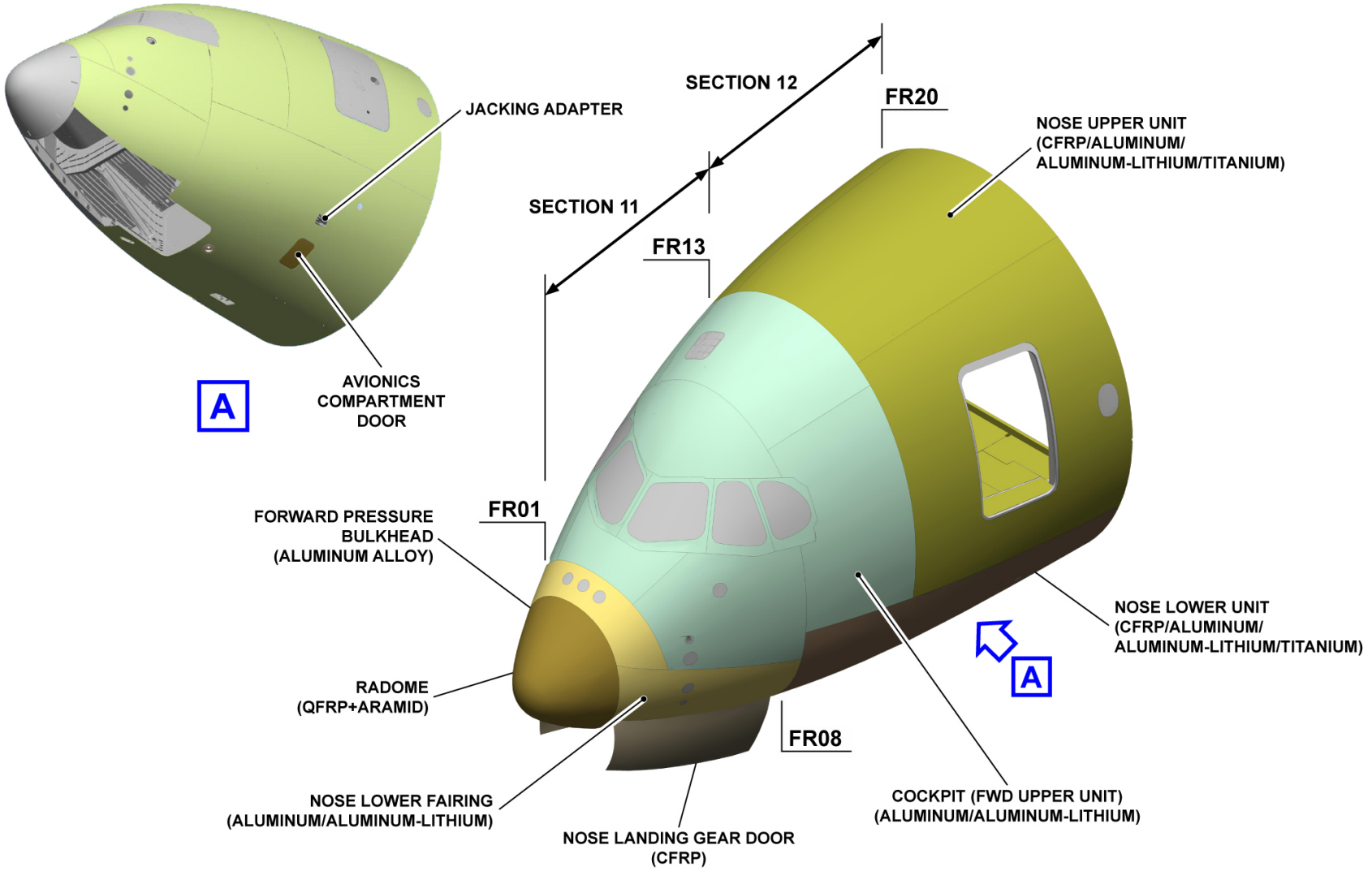
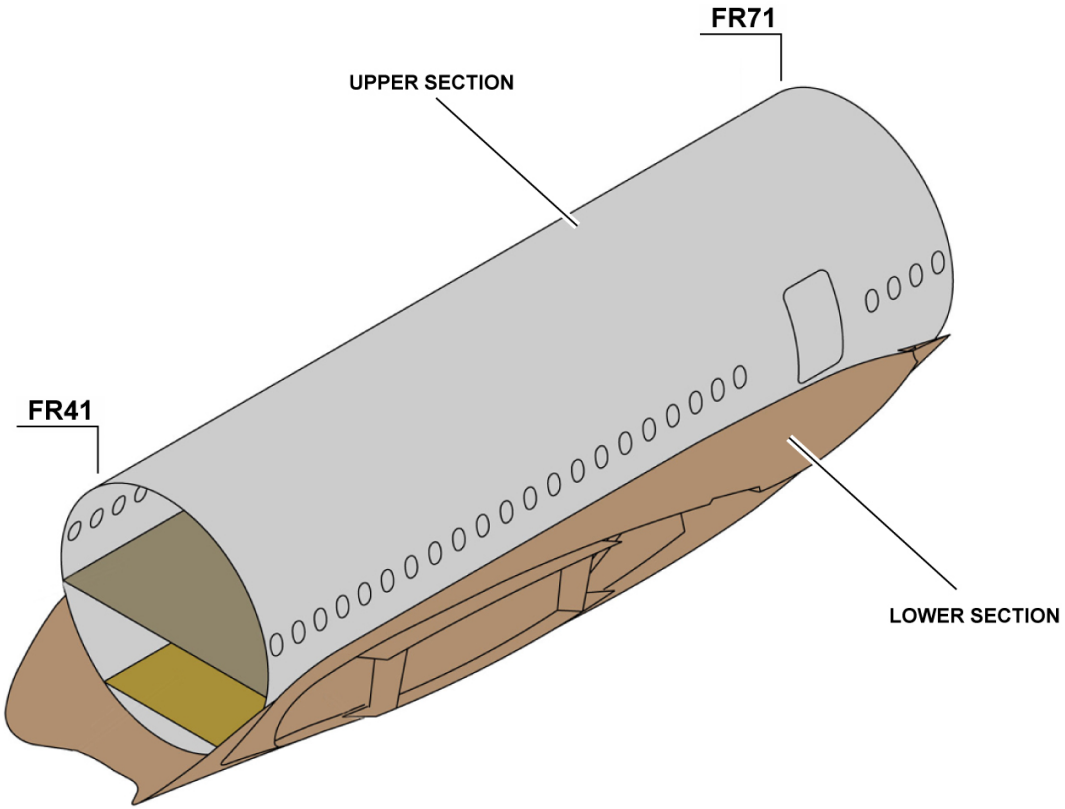


NOSE FORWARD FUSELAGE - NOSE UPPER UNIT ... RADOME

FUSELAGE DESCRIPTION (3)

Center Fuselage

The center fuselage (FR41 to FR71) is made of an upper and lower sections.



CENTER FUSELAGE

FUSELAGE DESCRIPTION (3)

Center Fuselage (continued)

Section Layout

The fuselage center section is made of:
- Frames (CFRP/titanium/alluminum alloy), stringers (CFRP), skin panels (CFRP) and the floor support structure (titanium/aluminum-lithium/aluminum/CFRP).

The fuselage center section includes:
- The center wing box and the floor support structure (CFRP/titanium/aluminum-lithium/aluminum)
- The keel beam (CFRP/titanium/aluminum-lithium/aluminum)
- The aft lower shell (CFRP/titanium/aluminum-lithium/aluminum)
- The forward lower shell (CFRP/titanium/aluminum-lithium/aluminum)
- The landing gear bay (CFRP/titanium/aluminum-lithium/aluminum).

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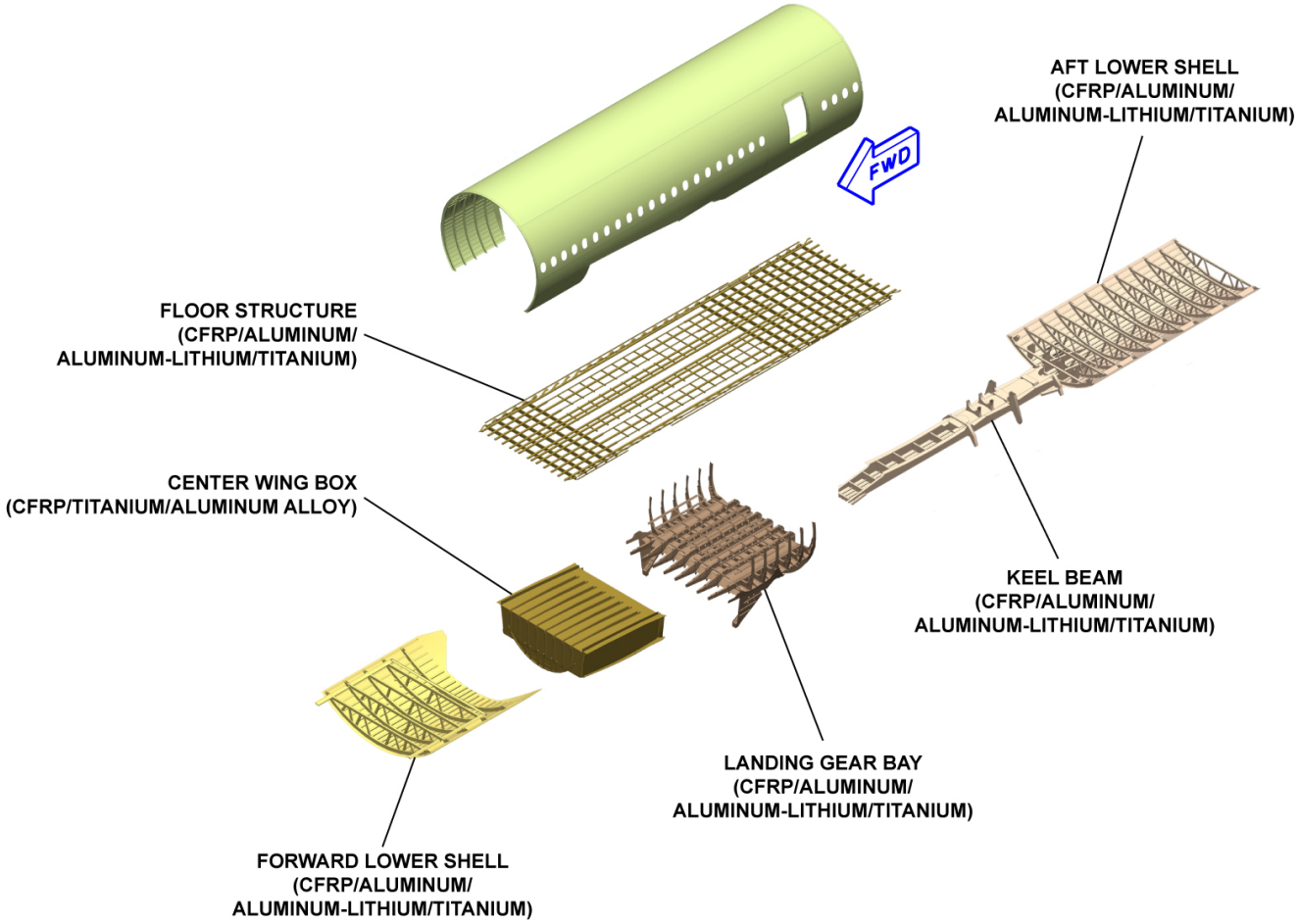

CENTER FUSELAGE - SECTION LAYOUT

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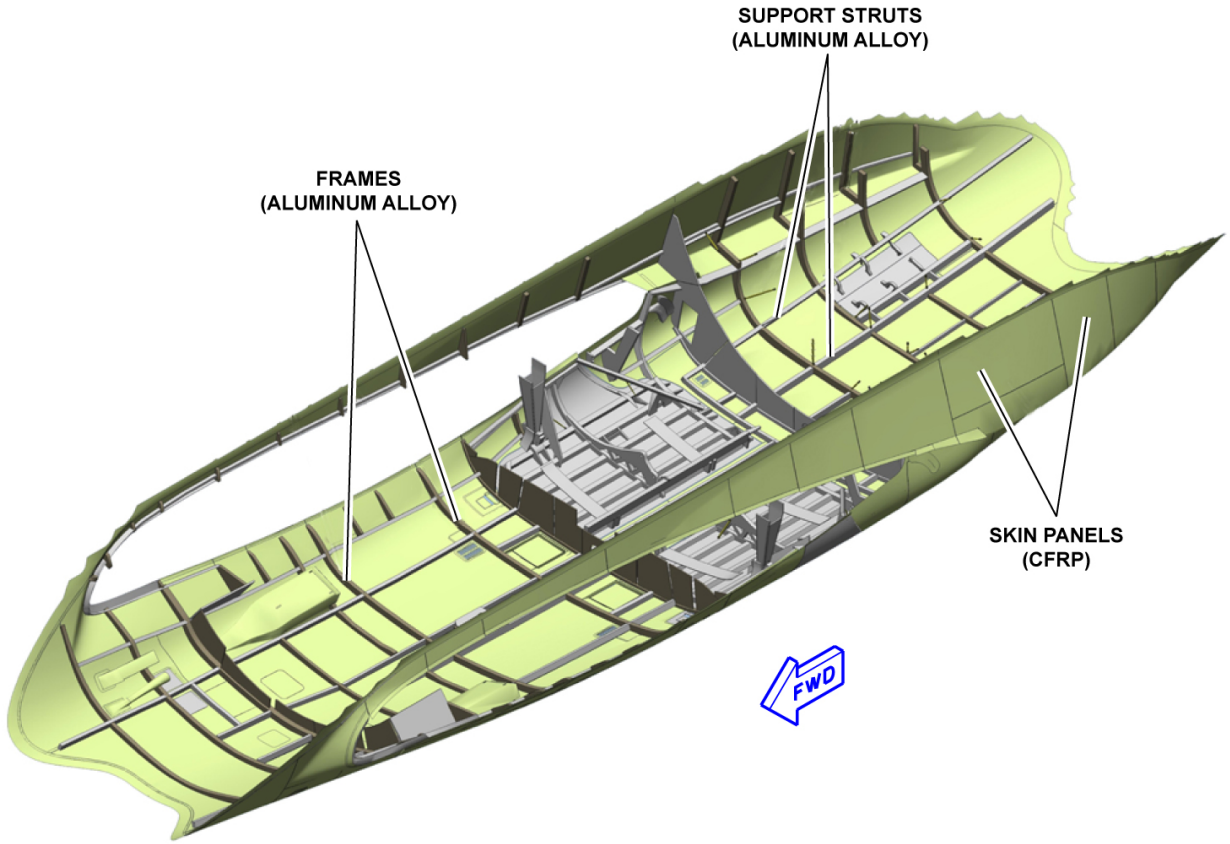
FUSELAGE DESCRIPTION (3)

Belly Fairing

The belly fairing includes a sub-structure made of aluminum alloy or CFRP frames and webs and attached to the fuselage with the fittings and rods.
The sub-structure gives support to the sandwich panels (carbon).
The belly fairing also includes the landing gear doors, external access panels and access doors for maintenance.



BELLY FAIRING AND MLG DOOR BAY

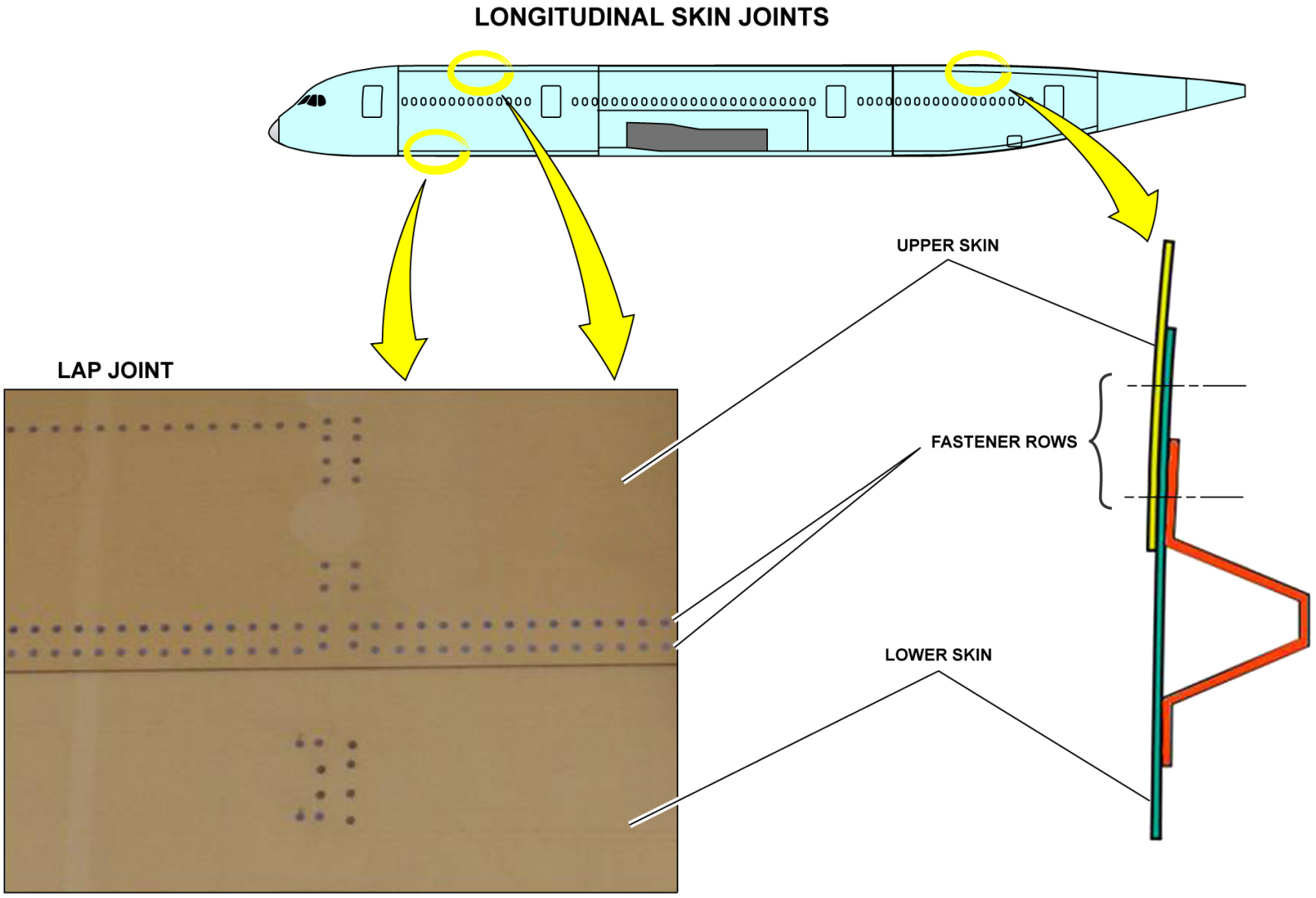
MLG: Main Landing Gear

BELLY FAIRING

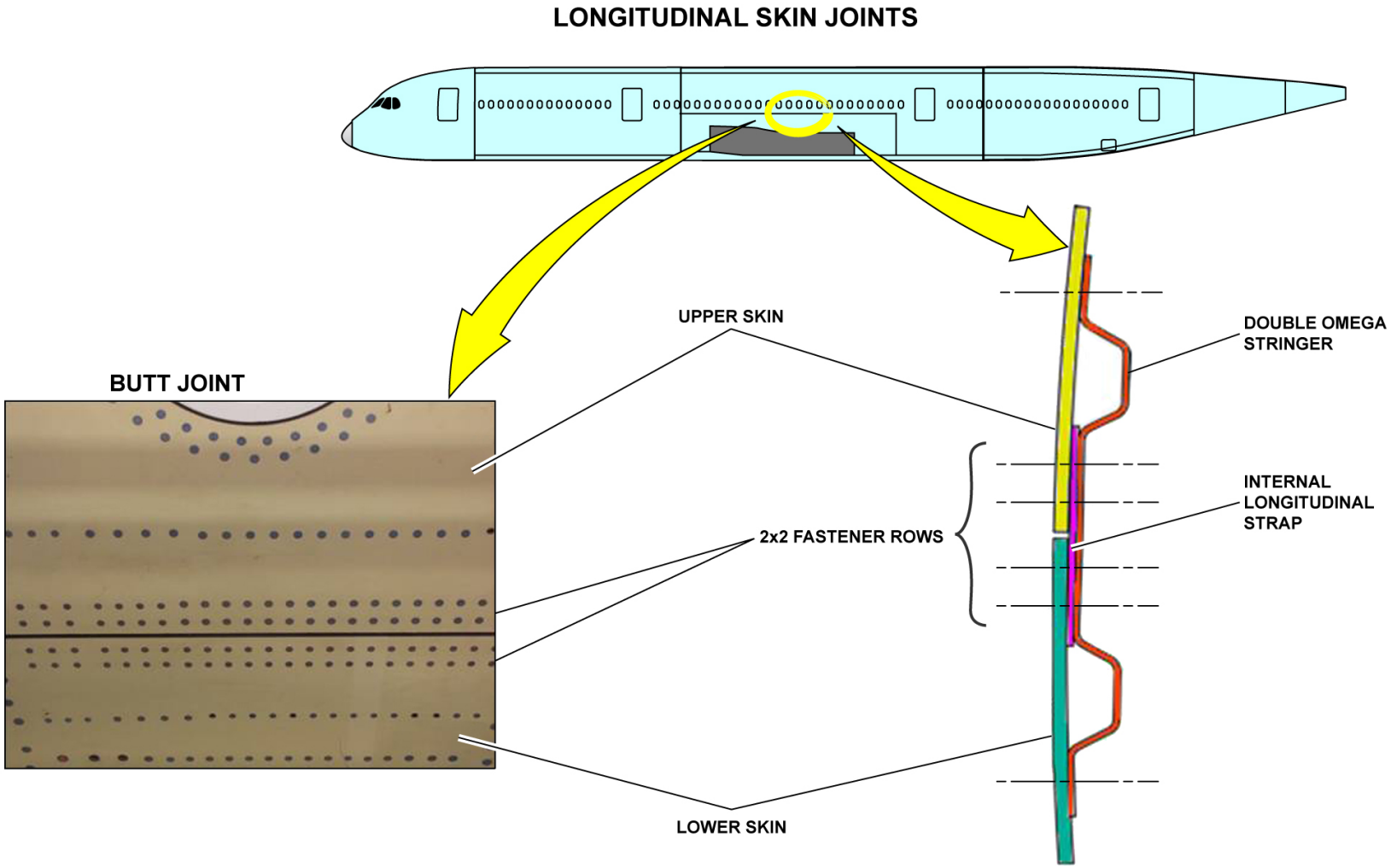
FUSELAGE DESCRIPTION (3)

Longitudinal Skin Joints

The longitudinal skin joints are longitudinal lap or butt joints with fasteners rows.



LONGITUDINAL SKIN JOINTS



LONGITUDINAL SKIN JOINTS

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FUSELAGE DESCRIPTION (3)

Orbital Skin Joints

At the typical joints, the skin panels are connected by an orbital (circumferential) strap and fasteners rows. The stringers are coupled by joint pieces. In the area of the orbital joints, all stringers are riveted to the skin.

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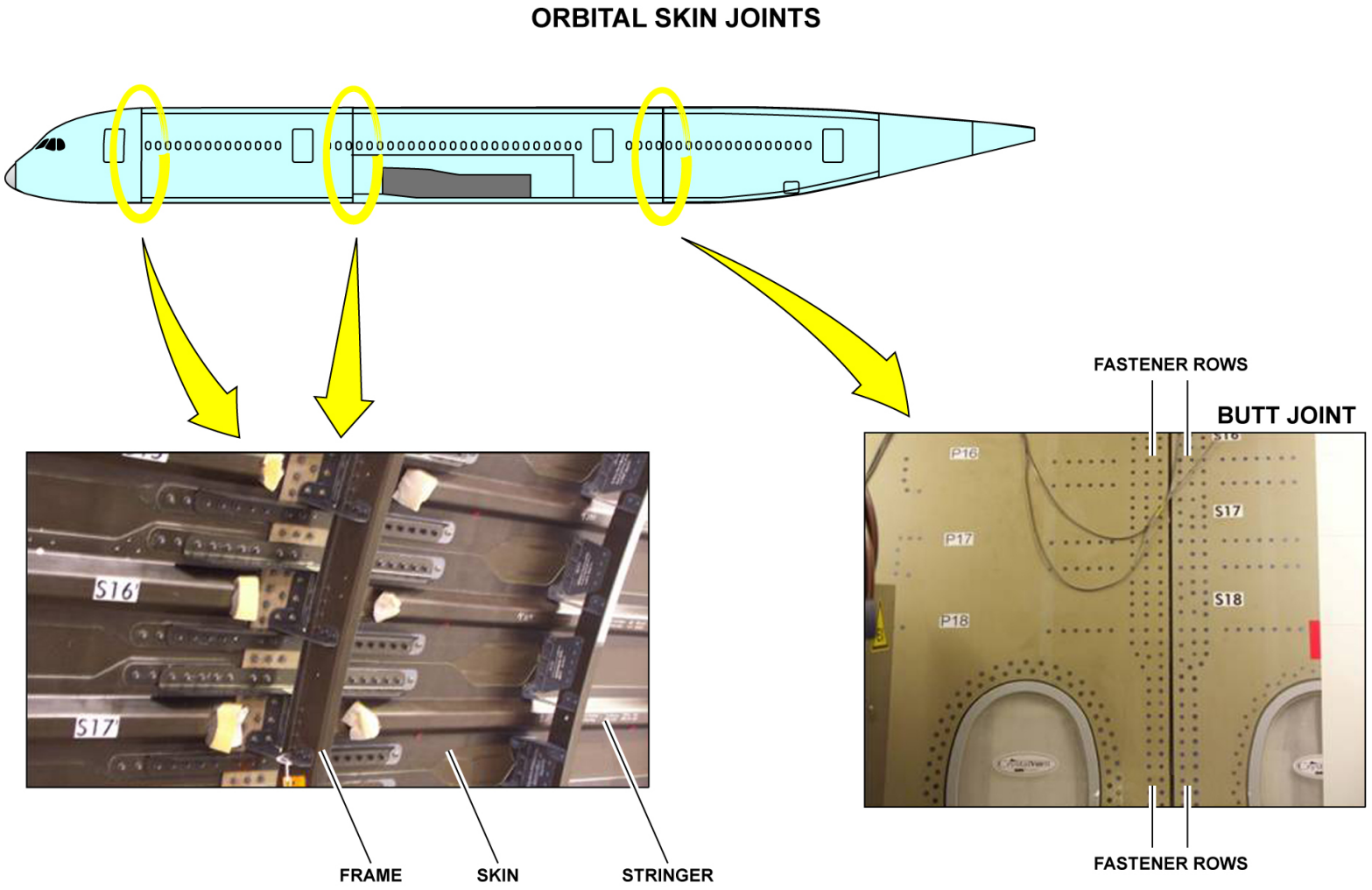

ORBITAL SKIN JOINTS

FUSELAGE DESCRIPTION (3)

Rear Fuselage

Rear Pressure Bulkhead

The rear pressure bulkhead divides the pressurized rear fuselage from the cone/rear fuselage, which is not pressurized. It is a monolithic composite panel, made from CFRP and stiffened by stiffeners integrated to the front face.

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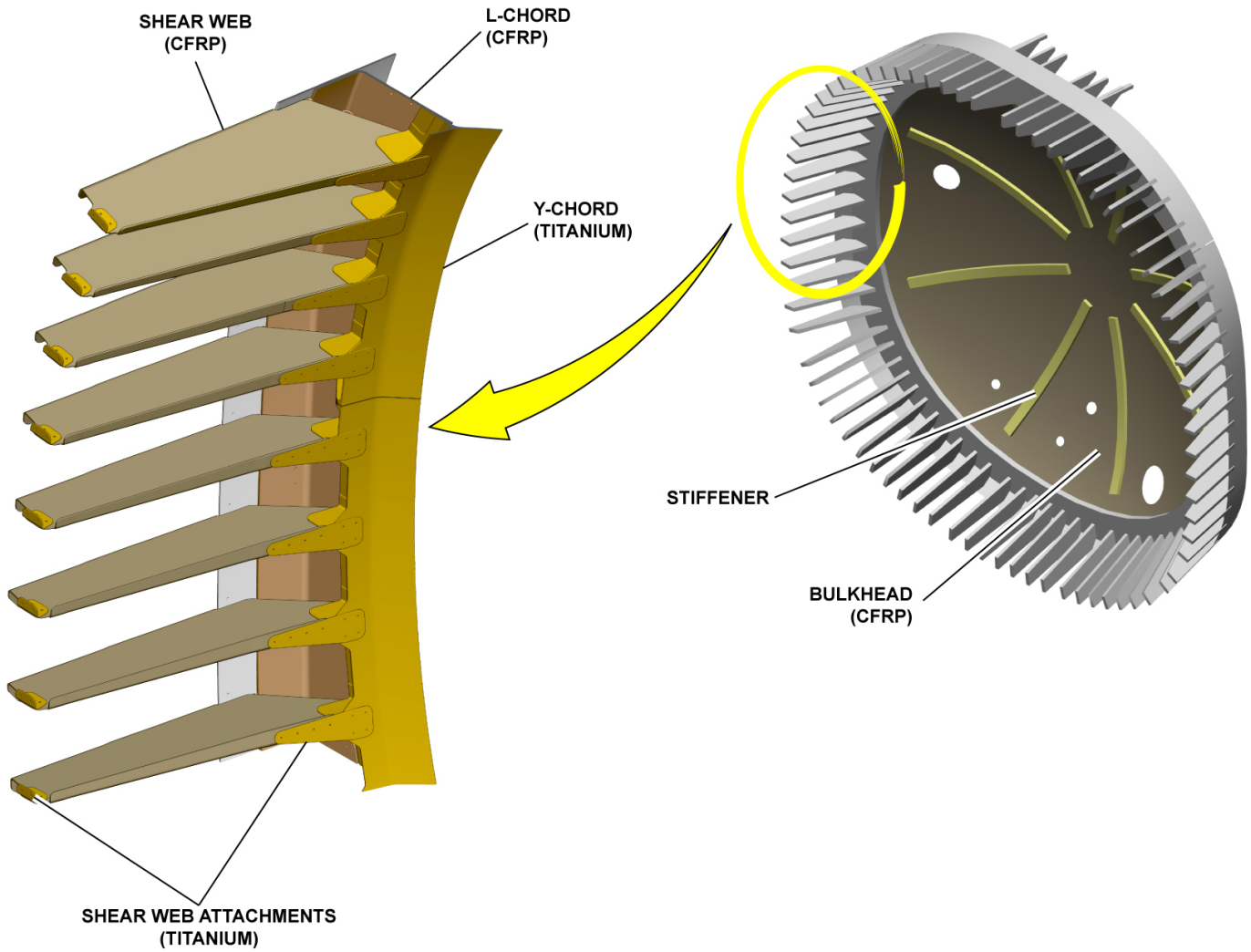

REAR FUSELAGE - REAR PRESSURE BULKHEAD

FUSELAGE DESCRIPTION (3)

Cone/Rear Fuselage

The cone/rear fuselage assembly is an unpressurized area of the fuselage.
The cone/rear fuselage has one section (section 19).
The cone/rear fuselage has attachment points for the vertical stabilizer, the THS and the Auxiliary Power Unit (APU).

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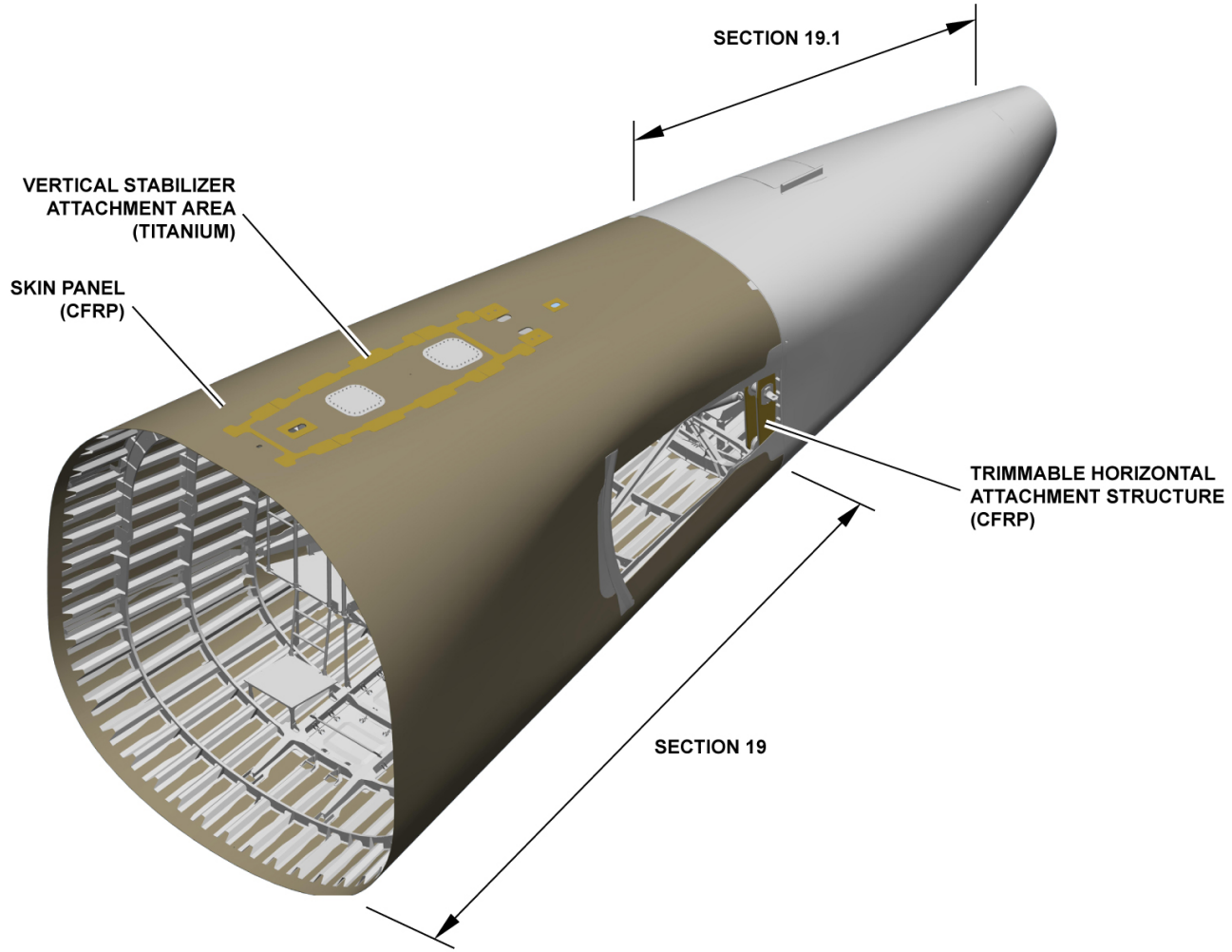

CONE/REAR FUSELAGE

FUSELAGE DESCRIPTION (3)

Cone/Rear Fuselage (continued)

Vertical Stabilizer Attachment Fittings

The vertical stabilizer attachment fittings are made of titanium alloy.

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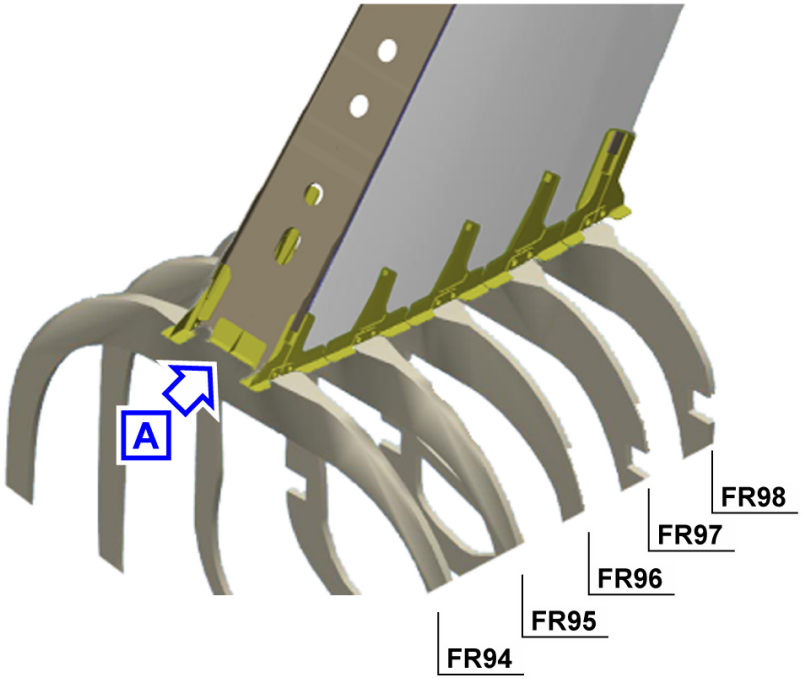

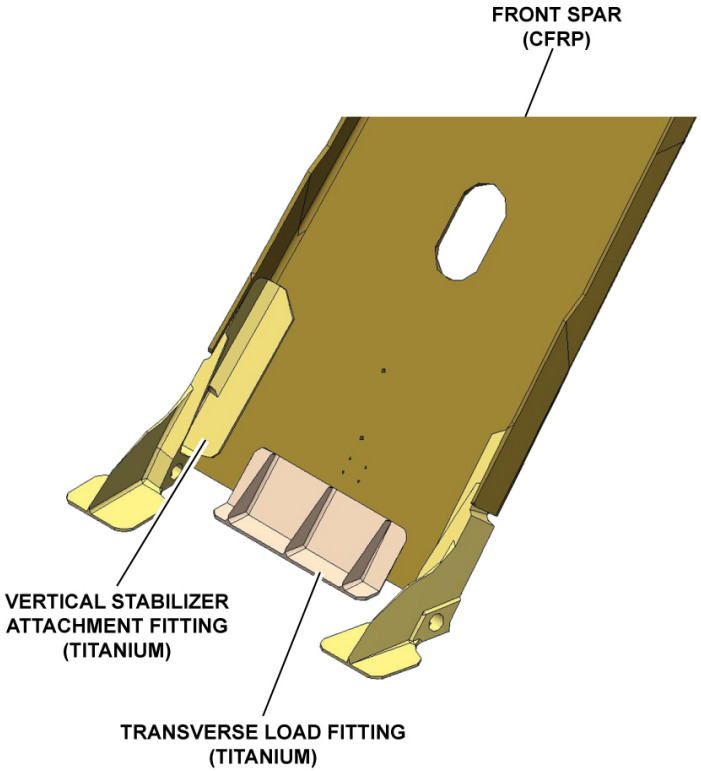

CONE/REAR FUSELAGE - VERTICAL STABILIZER ATTACHMENT FITTINGS

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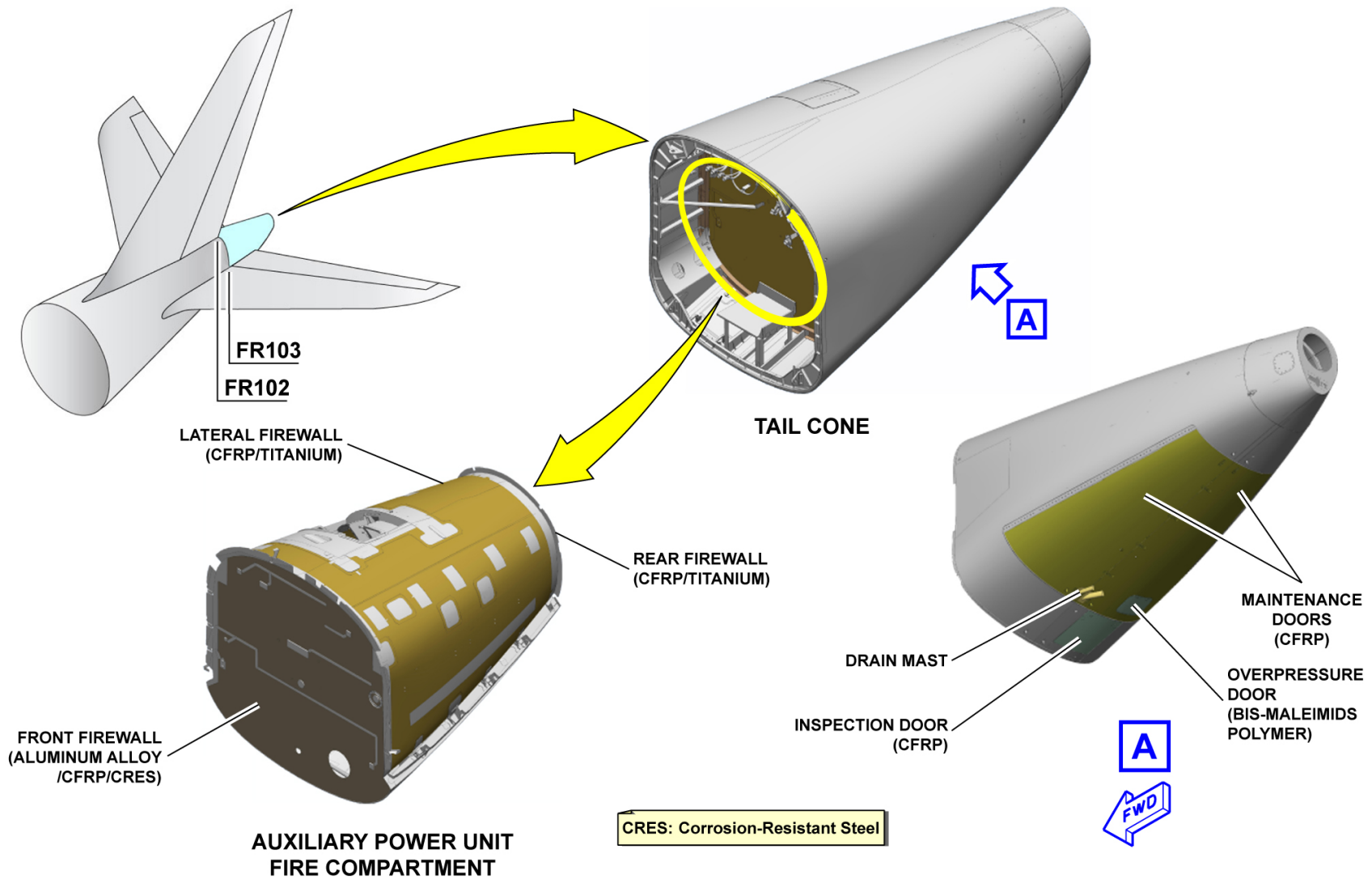
FUSELAGE DESCRIPTION (3)

Tail Cone

The tail cone is an unpressurized area and is attached to the cone/rear fuselage. It is possible to remove the tail cone as a unit. The tail cone is divided into three primary zones:
- The inspection zone: This zone allows access for inspection tasks.
- The APU compartment zone: This zone includes the APU and the related systems.
- The exhaust muffler zone.


FR103
FR102
TAIL CONE
A
LATERAL FIREWALL
(CFRP/TITANIUM)
REAR FIREWALL
(CFRP/TITANIUM)
FRONT FIREWALL
(ALUMINUM ALLOY
/CFRP/CRES)
AUXILIARY POWER UNIT
FIRE COMPARTMENT
CRES: Corrosion-Resistant Steel
MAINTENANCE
DOORS
(CFRP)
DRAIN MAST
OVERPRESSURE
DOOR
(BIS-MALEIMIDS
POLYMER)
INSPECTION DOOR
(CFRP)
A
FWD

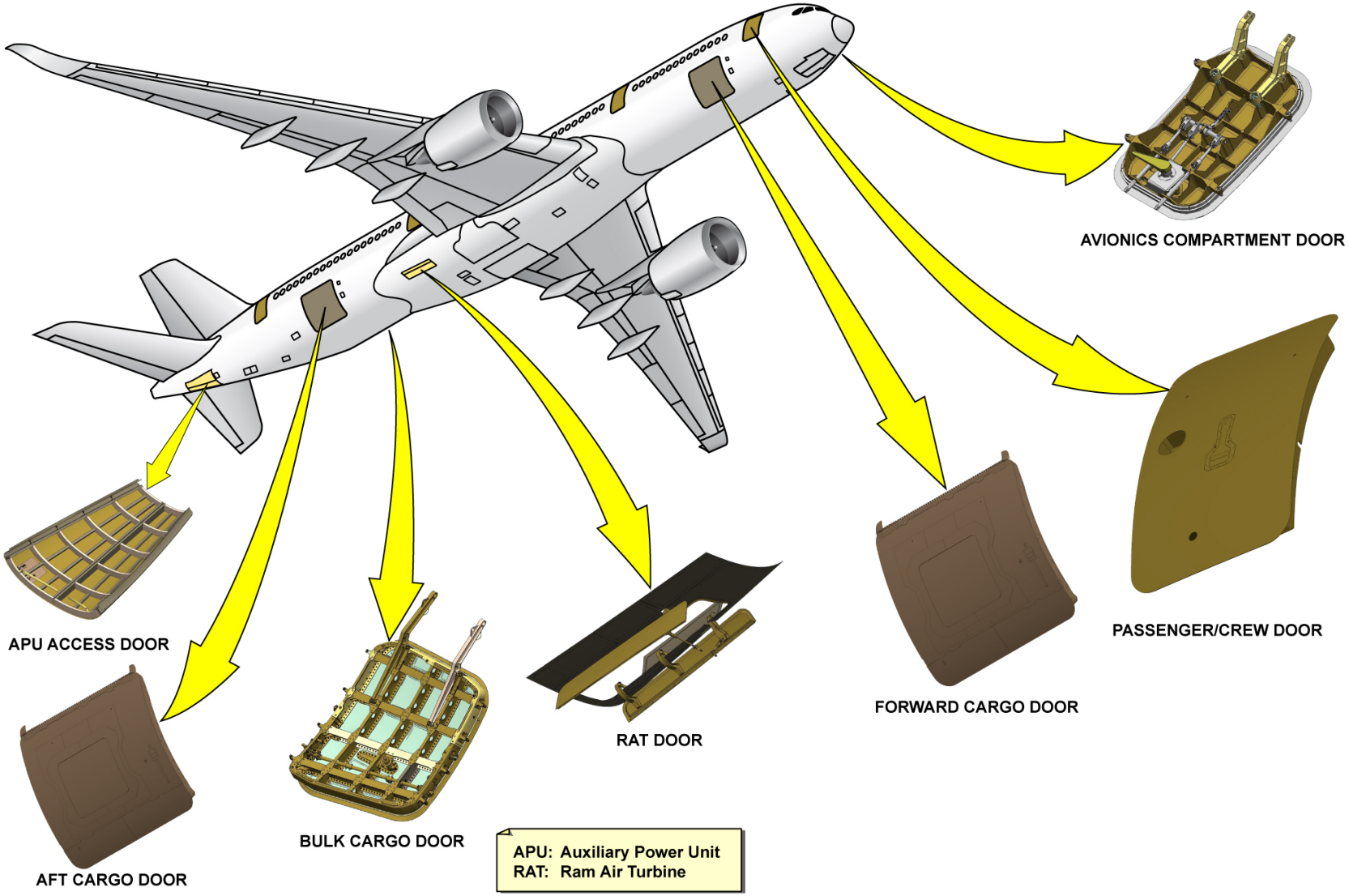
TAIL CONE

DOORS DESCRIPTION (3)

General

The fuselage has:
- The type A (2.1 m (83 in.) x (1.3 m (51 in.)) Passenger (PAX) doors
- The type C (2.1 m (83 in.) x (1.3 m (51 in.)) PAX doors
- Two cargo compartment doors
- One bulk cargo door
- Access doors for servicing and maintenance.

V2414251 - V00T0MM0 - VM51D2DOORS3001



GENERAL

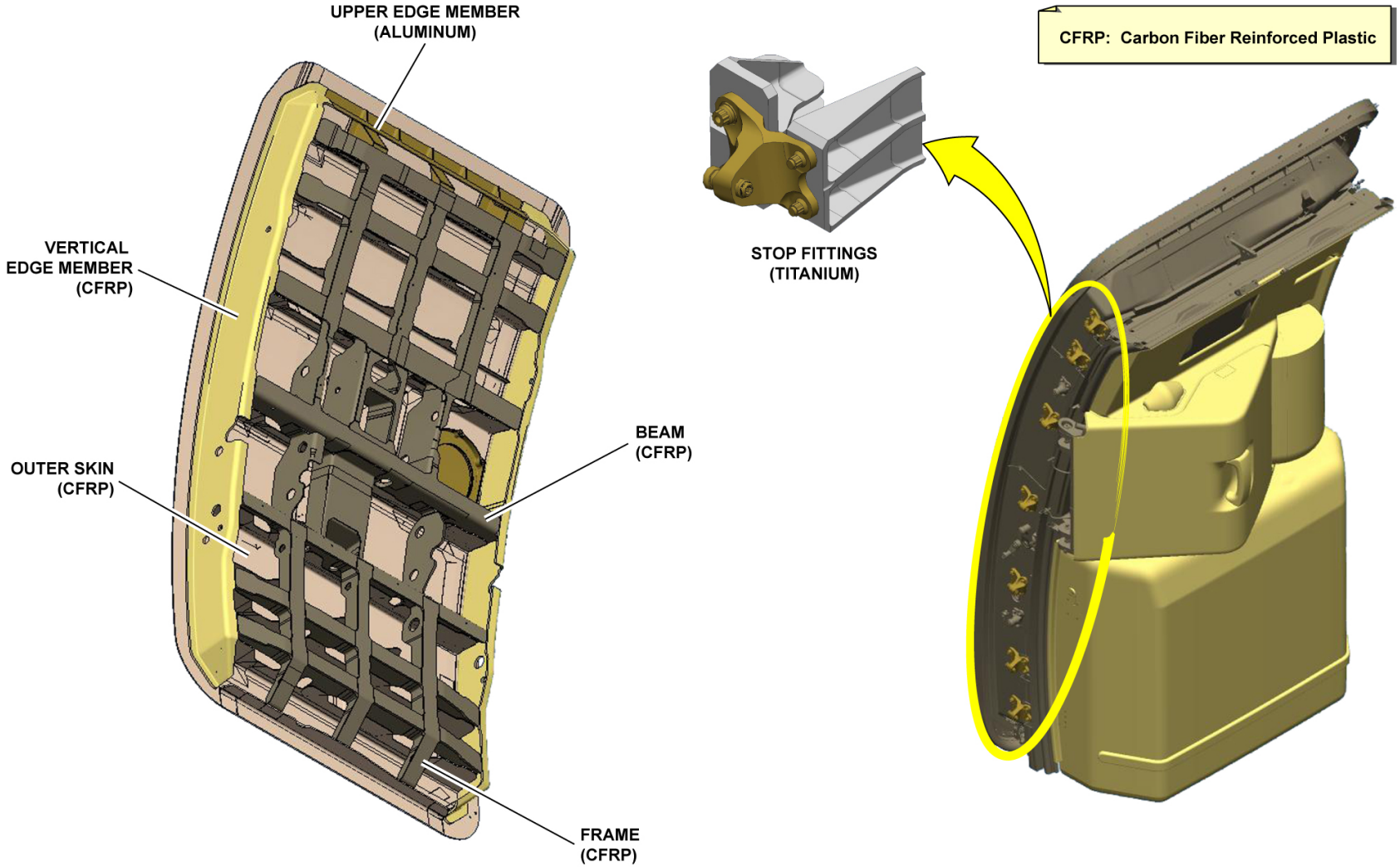
V2414251 - V00T0MM0 - VM51D2DOORS3001

DOORS DESCRIPTION (3)

Passenger (PAX) Doors

PAX doors:
The aircraft has eight PAX doors (type A and/or C), installed on each side of the fuselage made of Carbon Fiber Reinforced Plastic (CFRP). The PAX doors are of fail-safe, plug-type construction. It has outer and inner skins, segments, beams and two lateral frames on which hinge fittings and locking mechanisms are installed. Seven stop fittings installed on each side of the door transmits the resulting loads from the cabin pressure.

V2414251 - V00T0MM0 - VM51D2DOORS3001



PASSENGER (PAX) DOORS

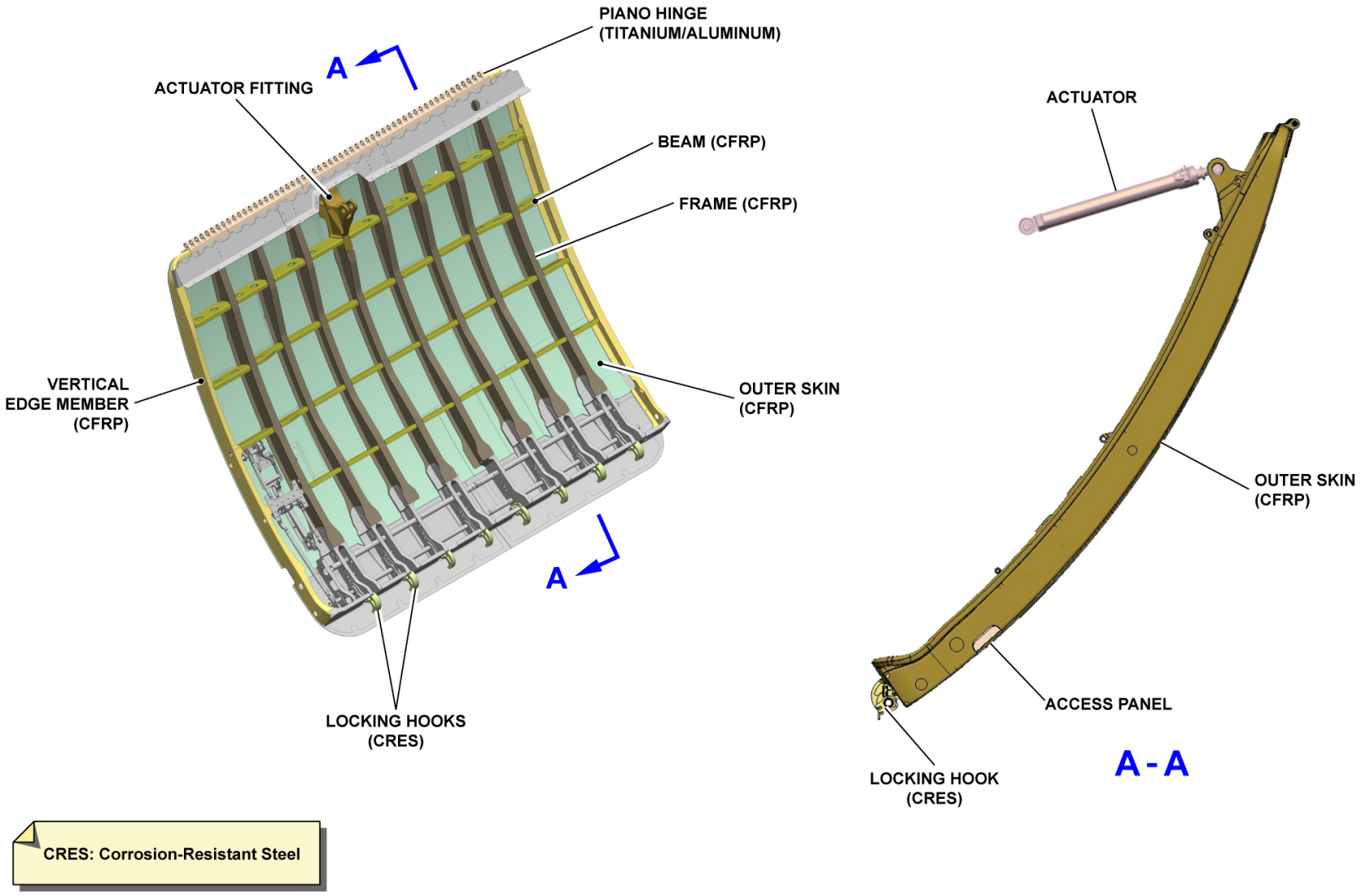
DOORS DESCRIPTION (3)

Cargo Compartment Doors

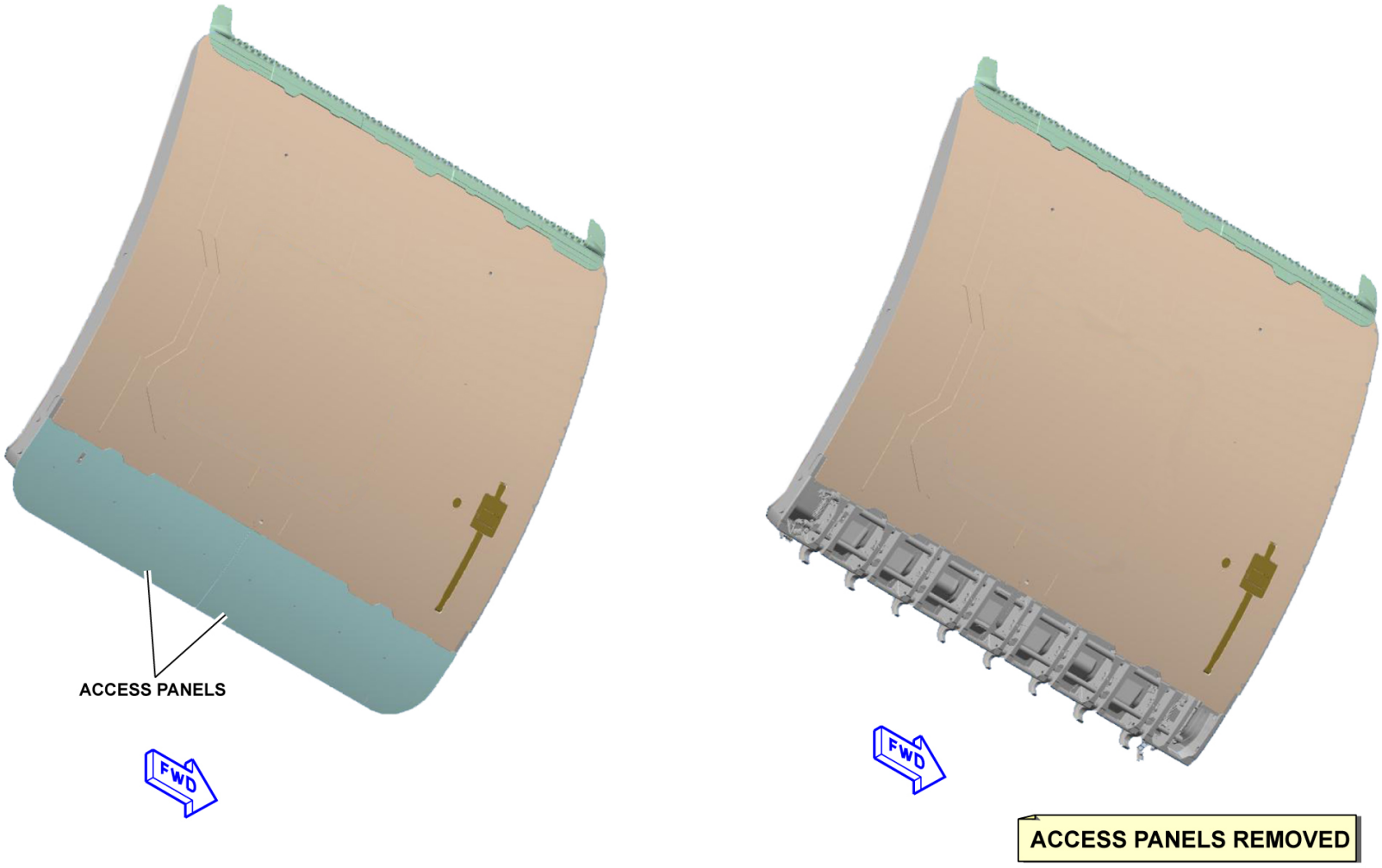
Forward and Rear Cargo Doors

Two doors in the lower RH side of the fuselage give access to the main cargo compartments and are made of CFRP.
The doors are designed to carry the hoop tension loads from internal pressure. To resist the loads, the doors have:
- Outer and inner skins
- An internal structure of circumferential frames. The upper ends of these frames have hinges for the door and the lower ends have attachment for the locking hooks.

The bottom of the outer skin has access panels (aluminum) for the inspection and maintenance of the door latch and locking mechanism.



CARGO COMPARTMENT DOORS - FORWARD AND REAR CARGO DOORS



CARGO COMPARTMENT DOORS - FORWARD AND REAR CARGO DOORS

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V2414251 - V00T0MM0 - VM51D2DOORS3001

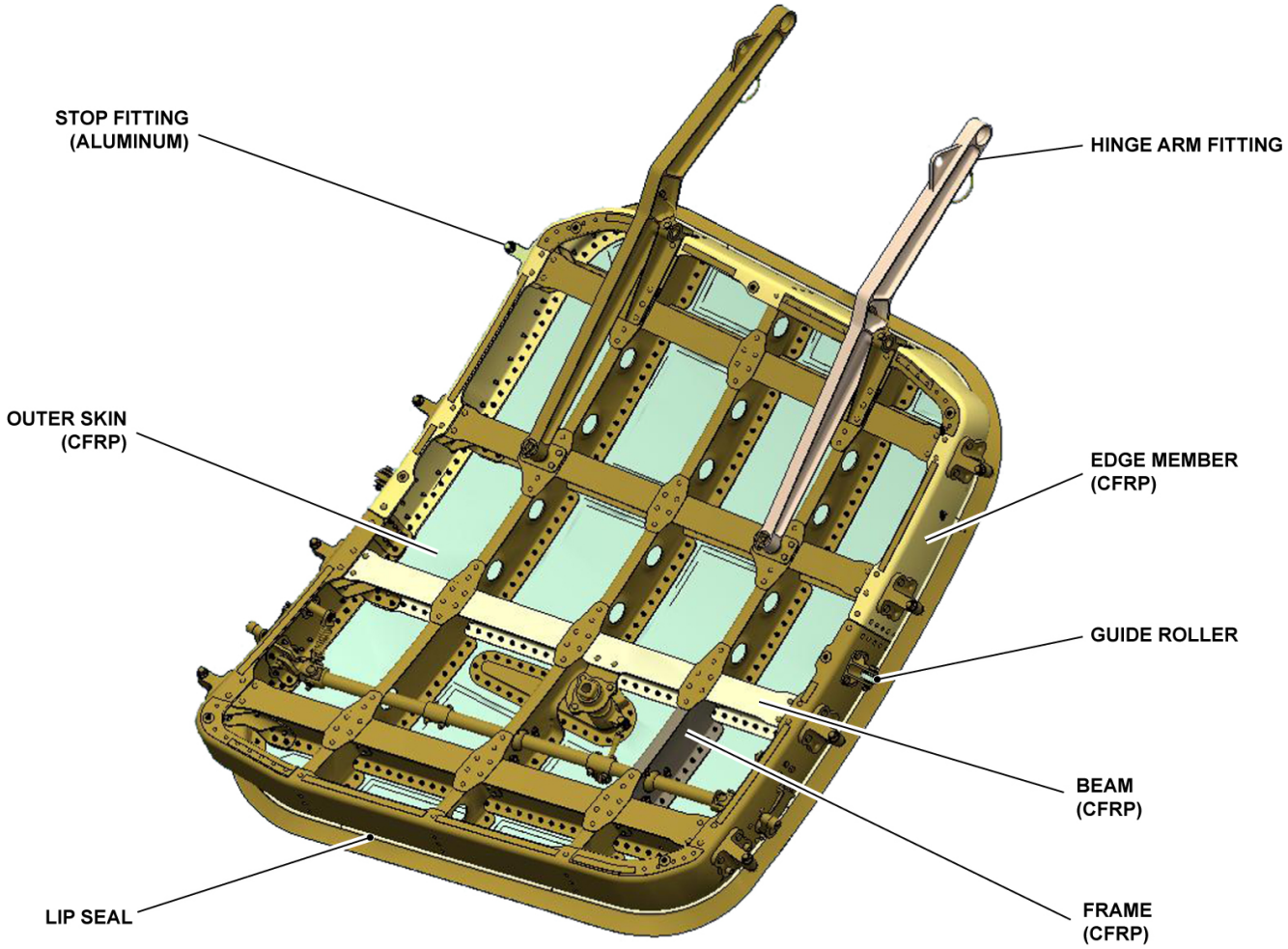
DOORS DESCRIPTION (3)

Cargo Compartment Doors (continued)

Bulk Cargo Door

The bulk cargo door is installed on the lower LH side of the fuselage and is made of CFRP. The bulk cargo door gives access to the bulk cargo compartment.
The bulk cargo door is a fail-safe, plug-type door. The bulk cargo door opens from an inner side and an outer side of the aircraft.

V2414251 - V00T0MM0 - VM51D2DOORS3001



CARGO COMPARTMENT DOORS - BULK CARGO DOOR

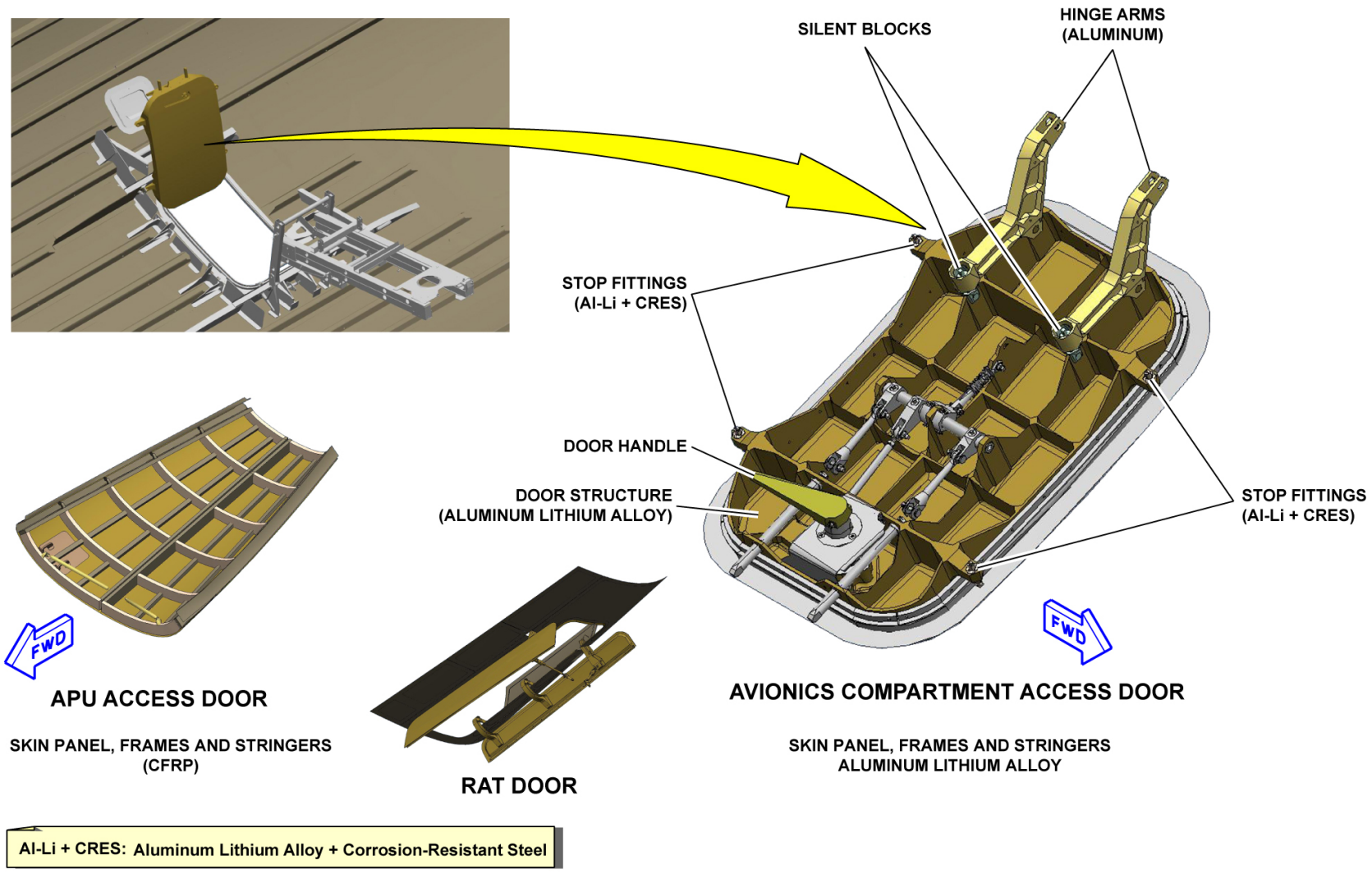
DOORS DESCRIPTION (3)

Access and Service Doors

The access door gives access for the maintenance of system and equipments and the inspection of the structure. Service doors in the fuselage give access to the servicing of the systems.
All the access and service doors which open and close manually are as follows:
- Avionics-compartment access door: The avionics-compartment access door (CFRP) is installed at the bottom of the fuselage in a pressurized area of the aircraft. The avionics-compartment access door opens from an inner side or an outer side.
- Ram Air Turbine (RAT) door: The RAT door is installed in an aft belly fairing. A spring strut keeps the RAT door in the closed position.
- Auxiliary Power Unit (APU) access doors.

The aircraft has access and service doors which are not illustrated. These doors are installed in the fuselage and belly fairing for the water, waste, external power and maintenance works.

V2414251 - V00T0MM0 - VM51D2DOORS3001


SILENT BLOCKS
HINGE ARMS (ALUMINUM)
STOP FITTINGS (Al-Li + CRES)
DOOR HANDLE
DOOR STRUCTURE (ALUMINUM LITHIUM ALLOY)
STOP FITTINGS (Al-Li + CRES)
FWD
APU ACCESS DOOR
SKIN PANEL, FRAMES AND STRINGERS (CFRP)
RAT DOOR
FWD
AVIONICS COMPARTMENT ACCESS DOOR
SKIN PANEL, FRAMES AND STRINGERS ALUMINUM LITHIUM ALLOY
Al-Li + CRES: Aluminum Lithium Alloy + Corrosion-Resistant Steel

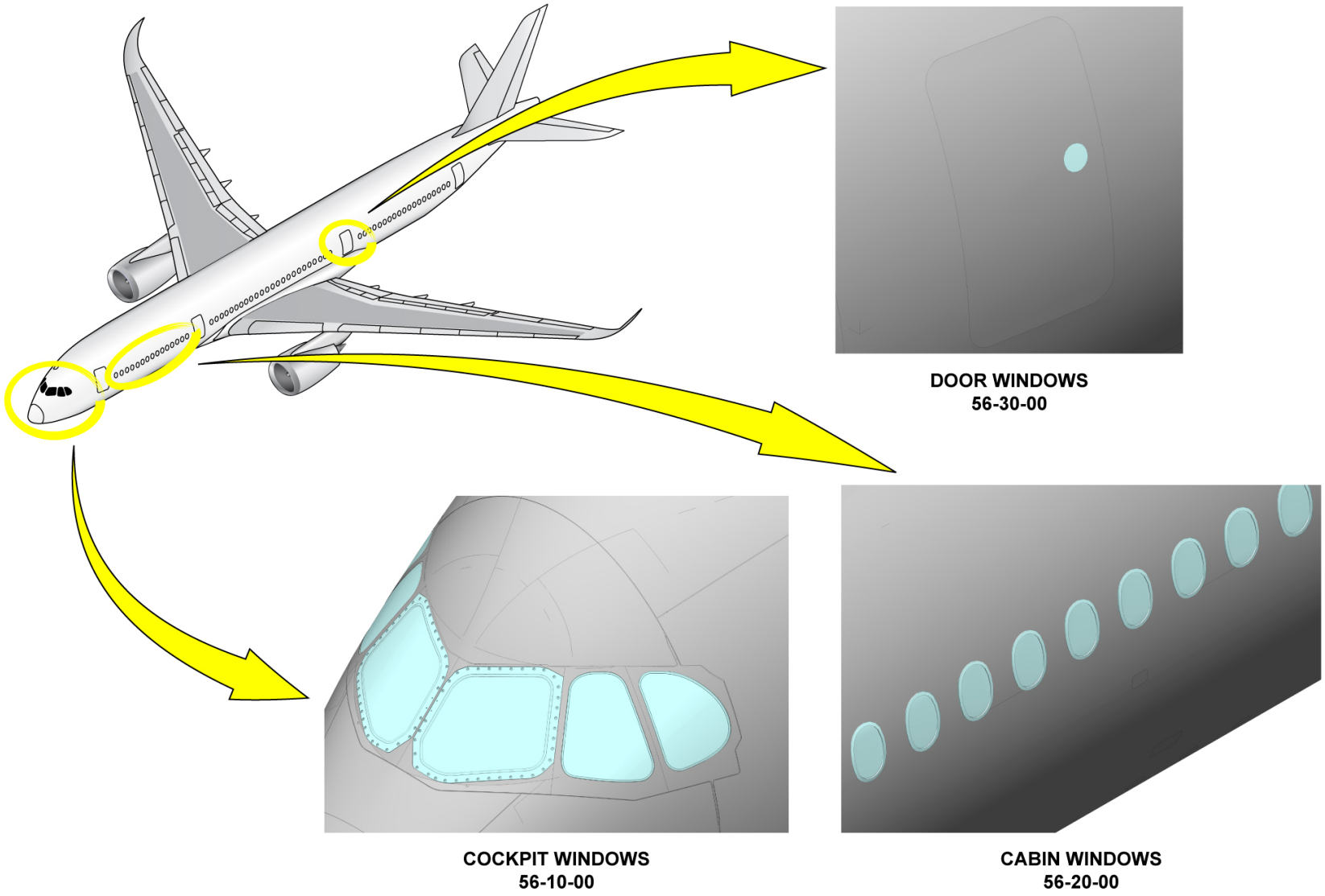
ACCESS AND SERVICE DOORS

WINDOWS DESCRIPTION (3)

General

The windows are installed:
- In the cockpit
- In the cabin
- On the doors.

All the windows installed in pressurized areas of the fuselage structure are fail-safe.


DOOR WINDOWS
56-30-00
COCKPIT WINDOWS
56-10-00
CABIN WINDOWS
56-20-00

GENERAL

WINDOWS DESCRIPTION (3)

Cockpit Windows

General Arrangements

There are six fixed windows in the cockpit. The windows are at the front and on the left and right side of the cockpit.
The cockpit has:
- Two front windshields
- Two forward lateral windows
- Two aft lateral windows.

The left and right windows are symmetrical.

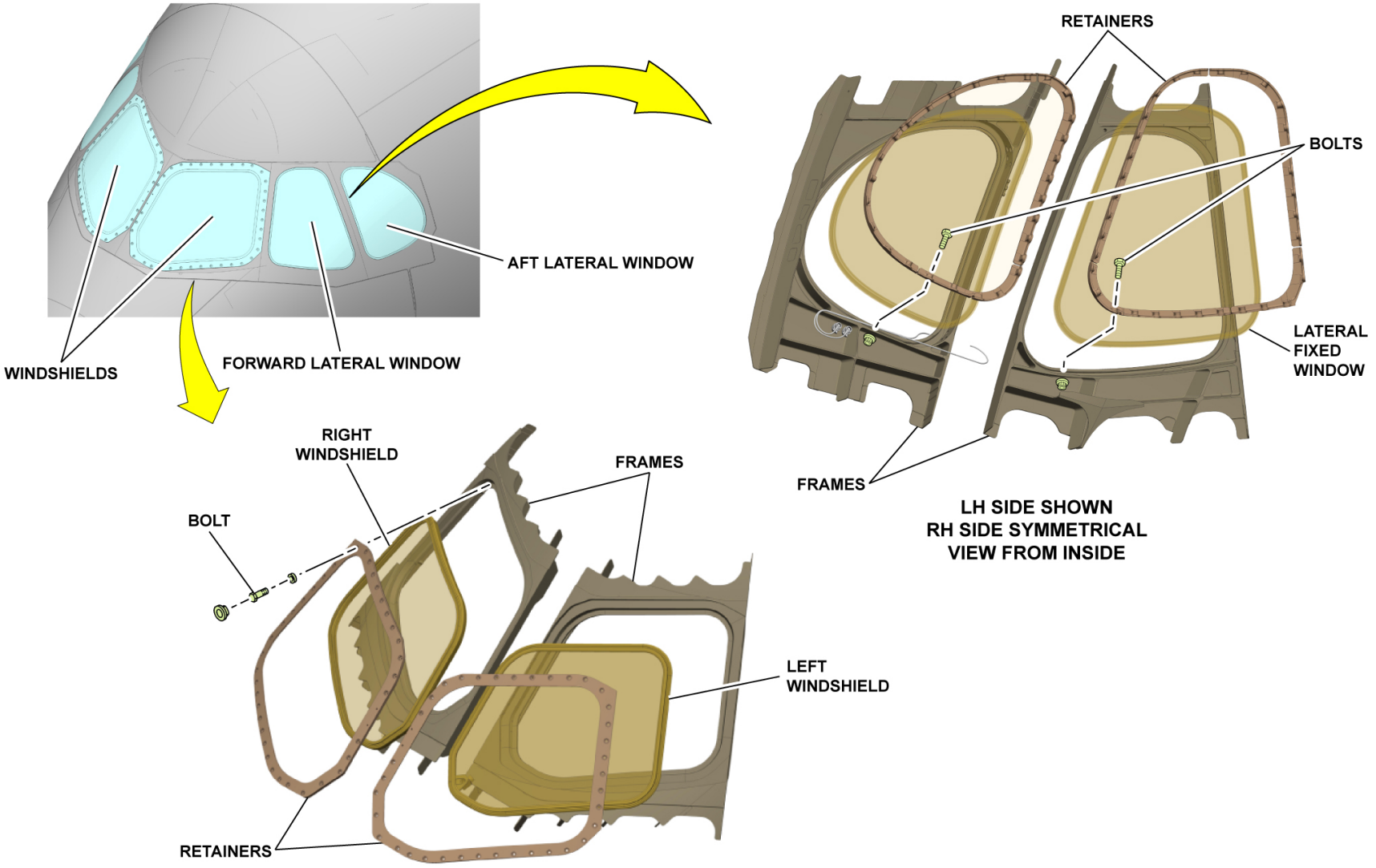
Windshields

Frame:
The windshield panels are installed in a frame integrated into the nose structure.
The retainers hold the panels in their position and are bolted to the outer face of the frame. Caps give protection to the fasteners.
Windshield panel assembly:
Windshields are replaced from outside.

Side Fixed Windows

Frame:
The forward and aft lateral windows are installed directly on to the frame in the aircraft structure.
Retainers hold the fixed window panel in position in its frame. The retainers are bolted to the inner face of the frame.
Window panel assembly:
Fixed windows are replaced from inside.

V2414251 - V00T0MM0 - VM51D3WINDO3001



COCKPIT WINDOWS - GENERAL ARRANGEMENTS ... SIDE FIXED WINDOWS

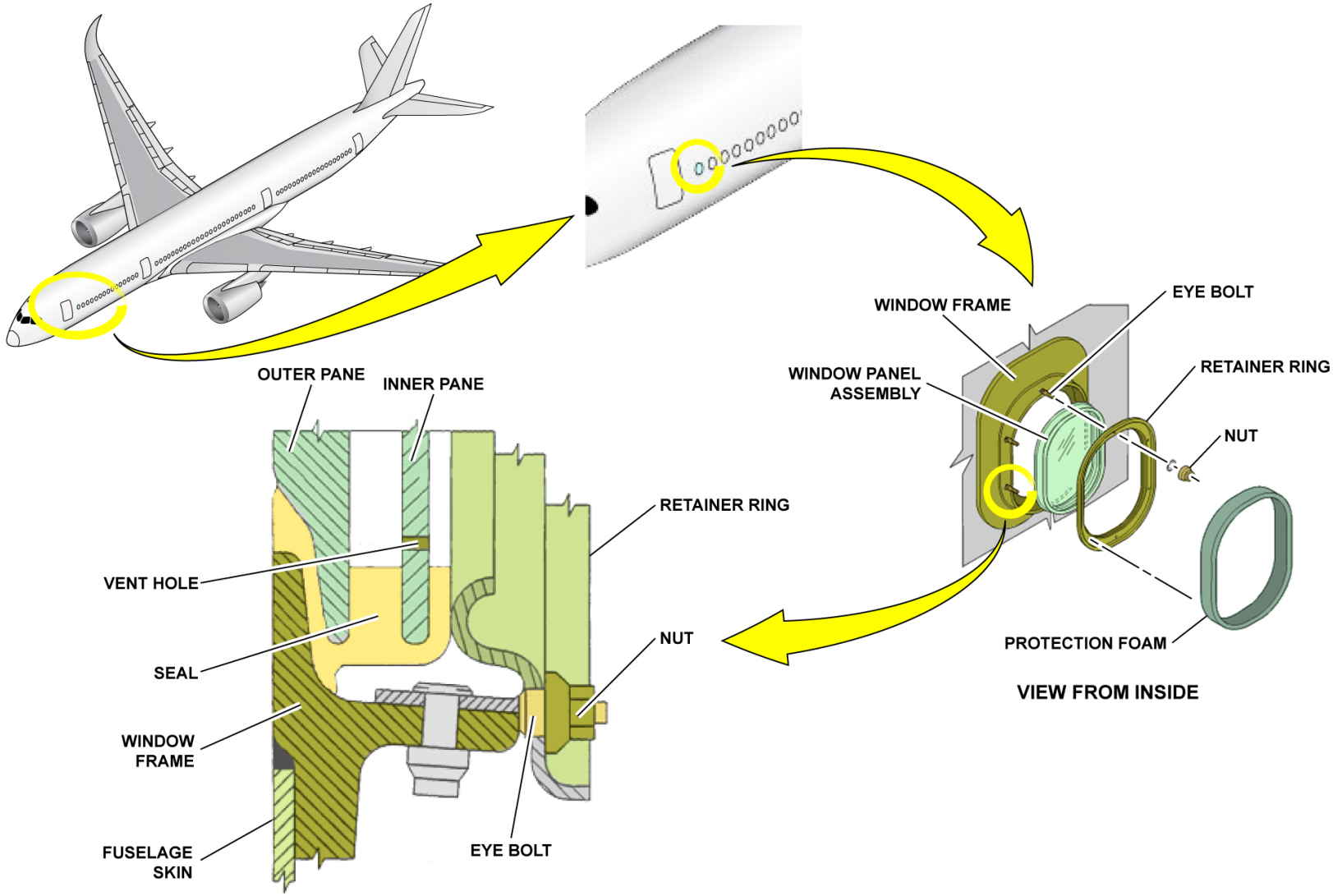
WINDOWS DESCRIPTION (3)

Cabin Windows

The windows are installed in window frames and make a smooth surface with the fuselage skin.
The cabin windows are installed/removed from the inner side of the aircraft.

Cabin Windows

The cabin windows are installed in the seating areas of the cabin.
A retainer ring, eye-bolts and nuts hold each cabin window in a window frame.
Each window panel assembly has an inner pane and an outer pane (acrylic).
There is a small hole (vent hole) at the bottom of the inner pane. This lets the pressure between the two panes stay the same as in the cabin.

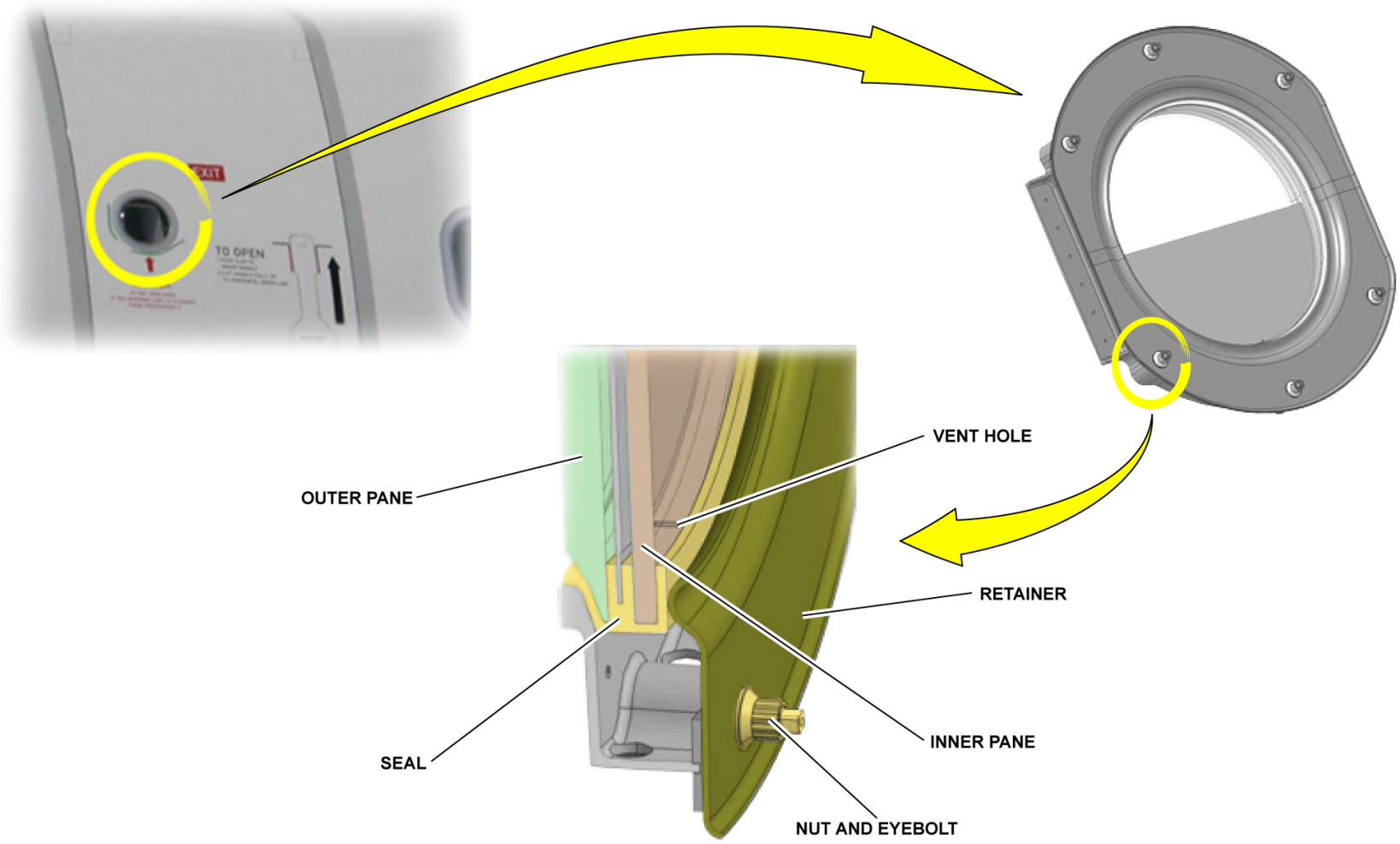


CABIN WINDOWS - CABIN WINDOWS

WINDOWS DESCRIPTION (3)

Door Windows

The PAX/crew doors and emergency exit doors have a circular window installed in a window frame. These windows are used for inspection and observation.
Each door window is installed near the inner handle. It is installed in a window frame, attached to the outer skin of the door. A retainer ring holds the door window in a window frame.
Each window panel assembly has an inner pane and an outer pane. There is a small hole (vent hole) at the bottom of the inner pane. This lets the pressure between the two panes stay the same as in the cabin.



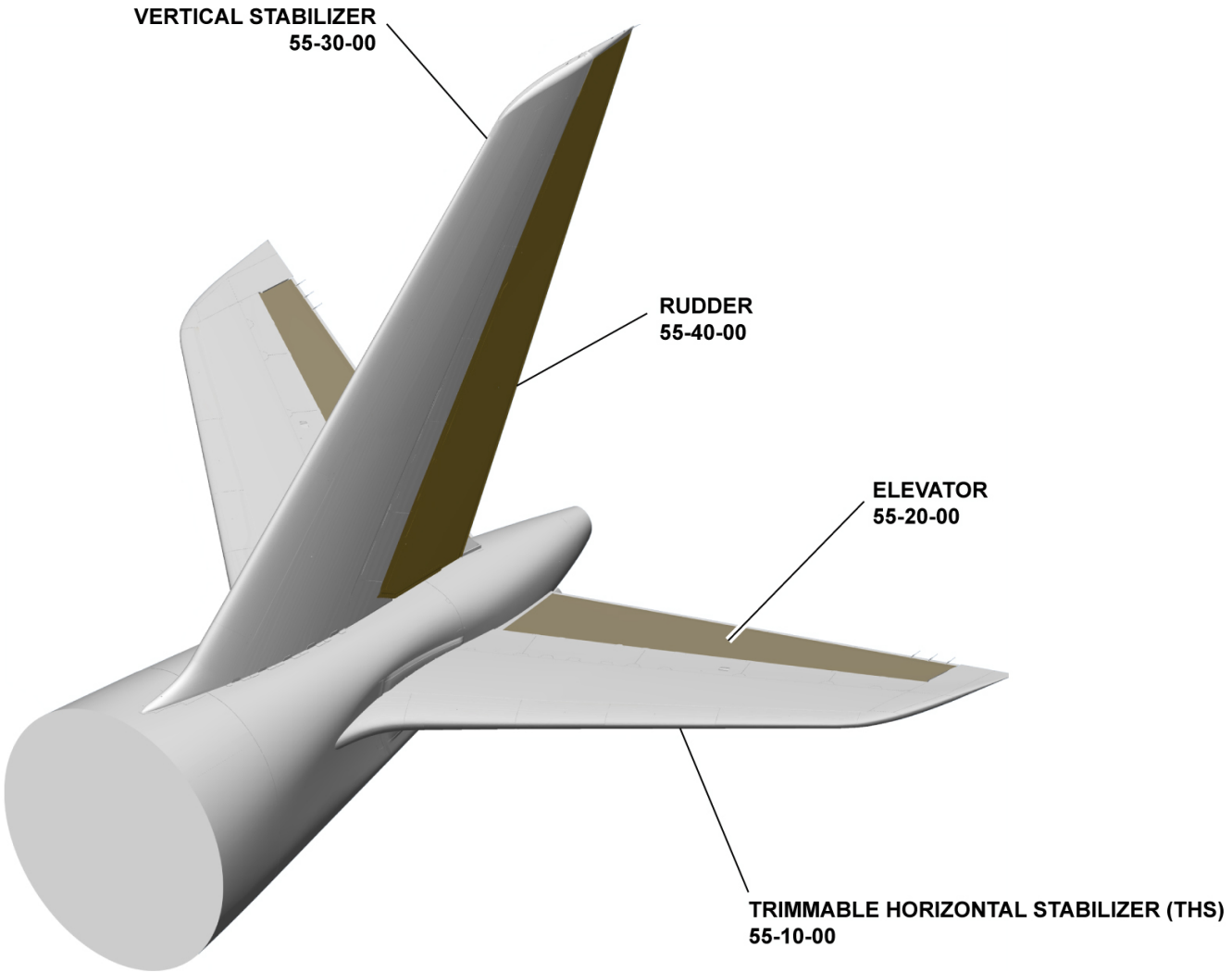
DOOR WINDOWS

STABILIZERS DESCRIPTION (3)

Stabilizers - General Arrangement

The stabilizers have:
- The THS
- Elevators
- The vertical stabilizer
- The rudder.

V2414251 - V00T0MM0 - VM51D4STABS3001



STABILIZERS - GENERAL ARRANGEMENT

V2414251 - V00T0MM0 - VM51D4STABS3001

STABILIZERS DESCRIPTION (3)

Trimmable Horizontal Stabilizer (THS)

General Arrangement

The THS primary structure includes:
- Spar boxes (center joint, LH side and RH side)
- The LE
- The TE
- The tip.

The spar boxes are the primary structure of the THS and hold all other components.

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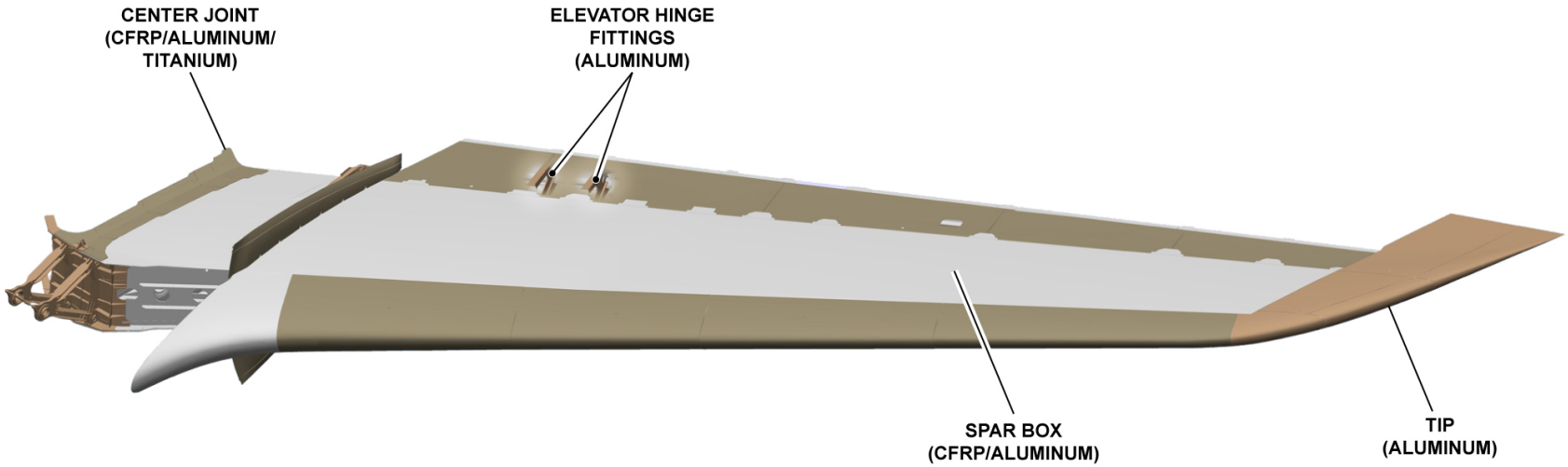

CFRP: Carbon Fiber Reinforced Plastic

TRIMMABLE HORIZONTAL STABILIZER (THS) - GENERAL ARRANGEMENT

V2414251 - V00T0MM0 - VM51D4STABS3001

STABILIZERS DESCRIPTION (3)

Trimmable Horizontal Stabilizer (THS) (continued)

Spar Boxes

The full spar box assembly has the LH and RH side boxes and the center joint. The center joint connects the LH and RH side spar-boxes to make one unit. Each spar box has a top and bottom skin panels, a front spar, a rear spar and ribs. The LH and the RH spar boxes are made of CFRP. The center joint is made of aluminum, titanium and CFRP parts.

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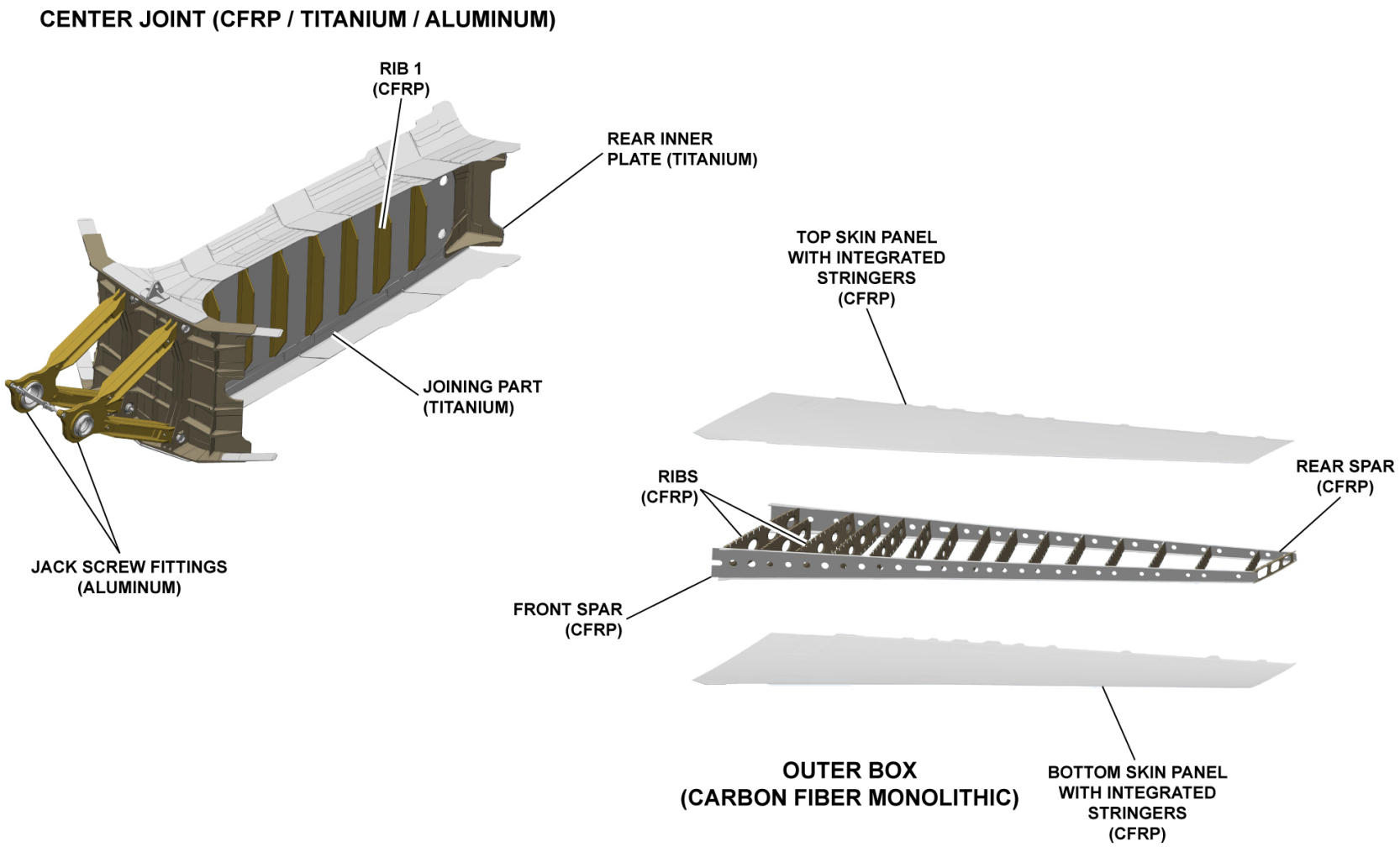


TRIMMABLE HORIZONTAL STABILIZER (THS) - SPAR BOXES

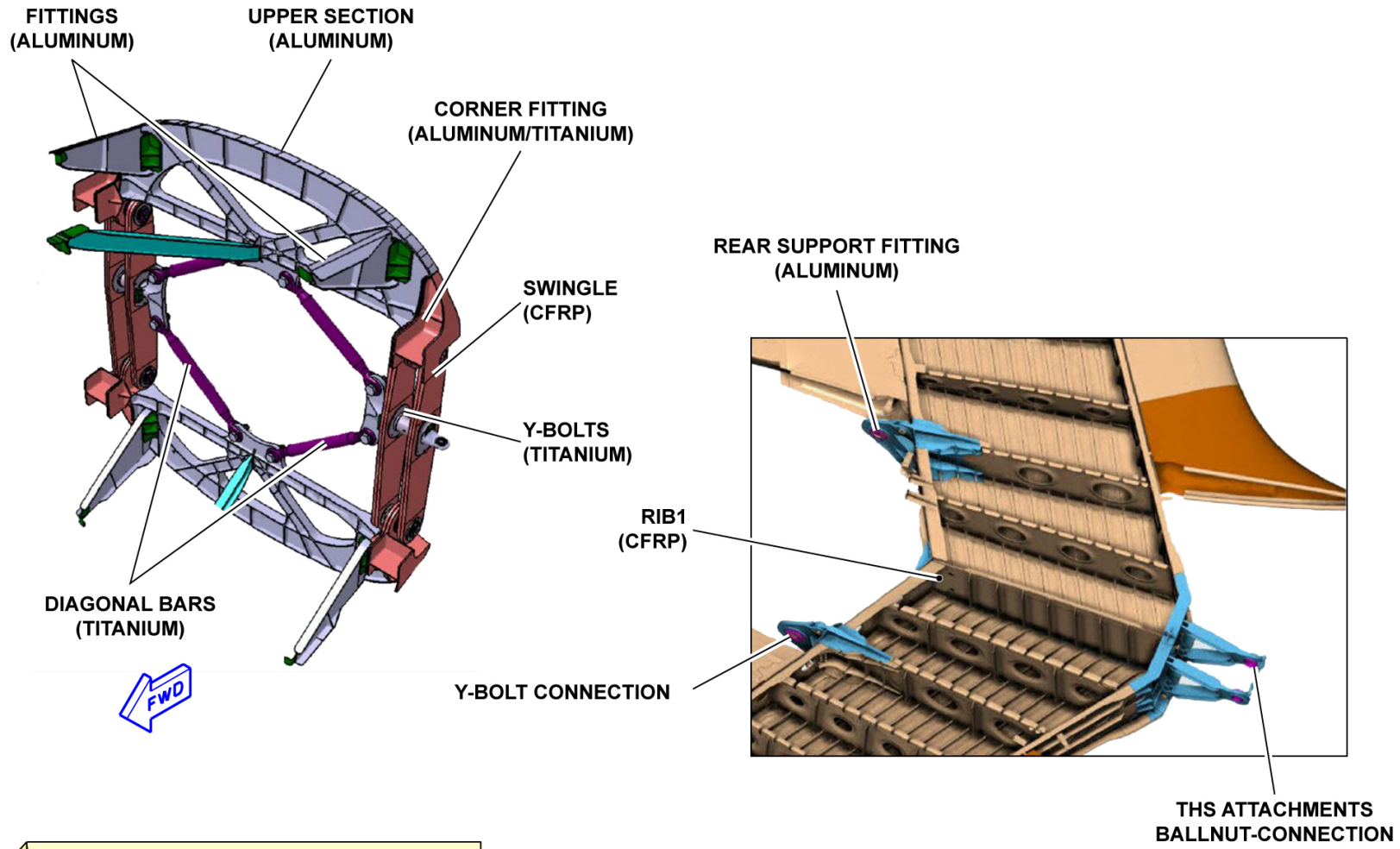
V2414251 - V00T0MM0 - VM51D4STABS3001

STABILIZERS DESCRIPTION (3)

Trimmable Horizontal Stabilizer (THS) (continued)

THS attachments

The THS is connected to the THS actuator ball nut (at the front) and to the Y bolts (at the rear).



TRIMMABLE HORIZONTAL STABILIZER (THS) - THS ATTACHMENTS

V2414251 - V00T0MM0 - VM51D4STABS3001

STABILIZERS DESCRIPTION (3)

Trimmable Horizontal Stabilizer (THS) (continued)

Leading Edge (LE)

The LE makes the front aerodynamic contour of the THS.
The THS LE includes LE ribs. LE ribs are made of CFRP.
The THS LE has an aerodynamic D-shape contour and attached to the front spar and the skin panels of the THS.
The THS LE is made of CFRP material. Each THS LE part has an anti-erosion stainless steel strap.
Each THS LE section is a full component, which includes an upper and lower panel, and a LE nose plate.
The upper and lower LE panels are made of CFRP.

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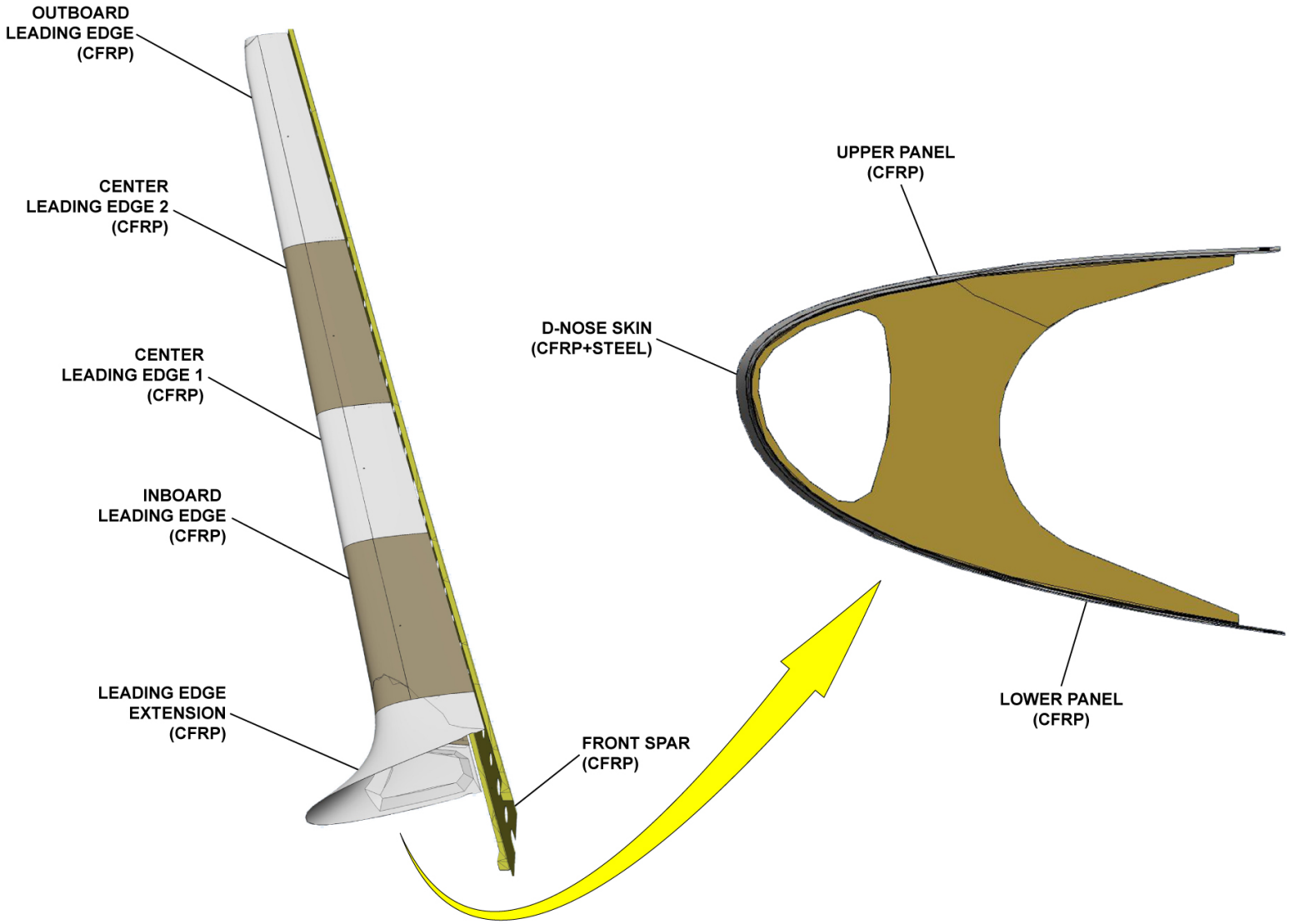


TRIMMABLE HORIZONTAL STABILIZER (THS) - LEADING EDGE (LE)

V2414251 - V00T0MM0 - VM51D4STABS3001

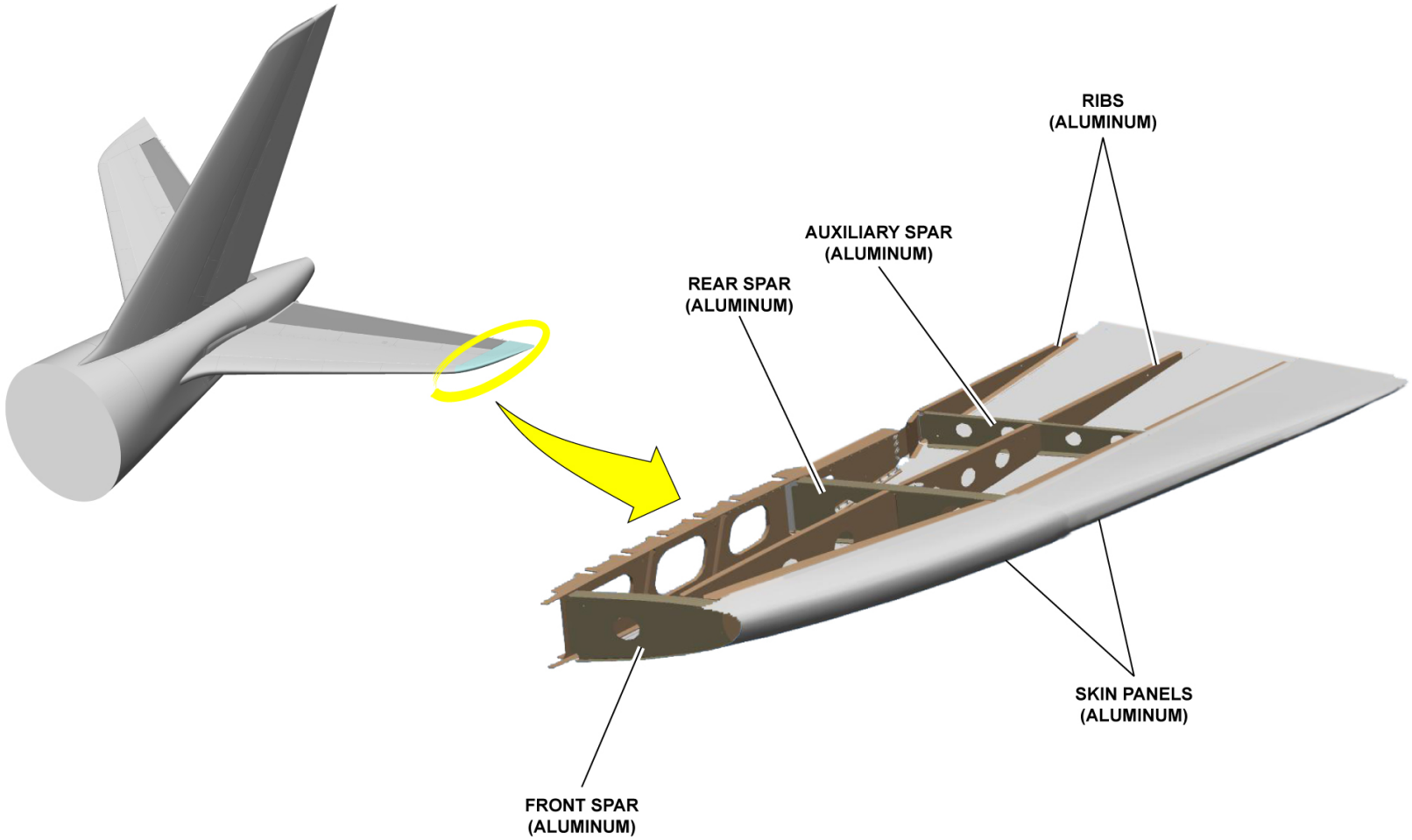
STABILIZERS DESCRIPTION (3)

Trimmable Horizontal Stabilizer (THS) (continued)

Tips

The THS tips complete the aerodynamic shape of the THS LE. The skin panels, spars and ribs are made of aluminum alloy. Static dischargers are attached to the rear and outboard edges of the tips.

V2414251 - V00T0MM0 - VM51D4STABS3001



TRIMMABLE HORIZONTAL STABILIZER (THS) - TIPS

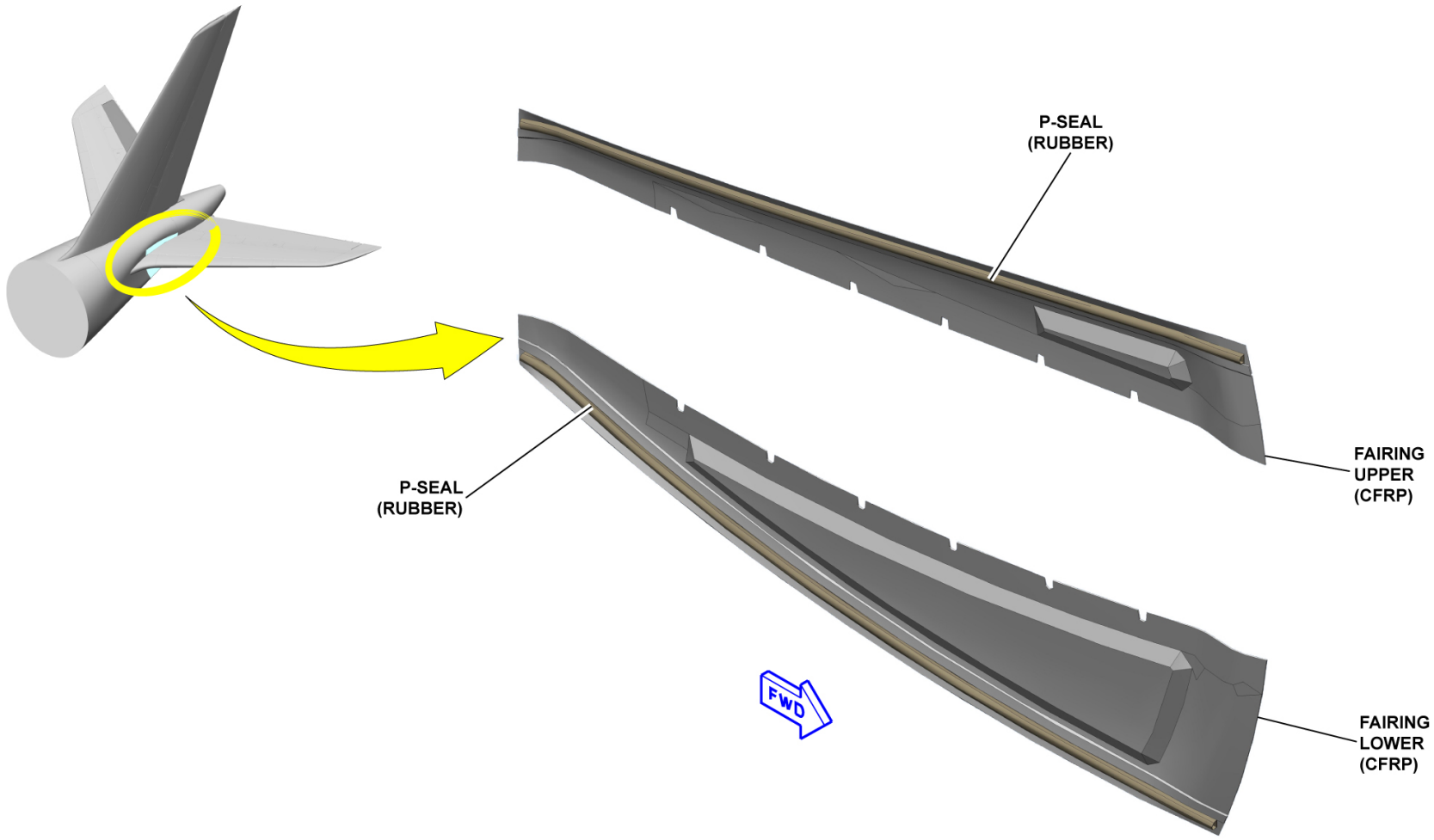
STABILIZERS DESCRIPTION (3)

Trimmable Horizontal Stabilizer (THS) (continued)

Aprons

The THS aprons give an aerodynamic seal between the THS and the fuselage. The THS aprons are made of CFRP. To decrease the friction between the THS aprons and the fuselage, the flexible p-seal is attached to the THS aprons.

V2414251 - V00T0MM0 - VM51D4STABS3001



TRIMMABLE HORIZONTAL STABILIZER (THS) - APRONS

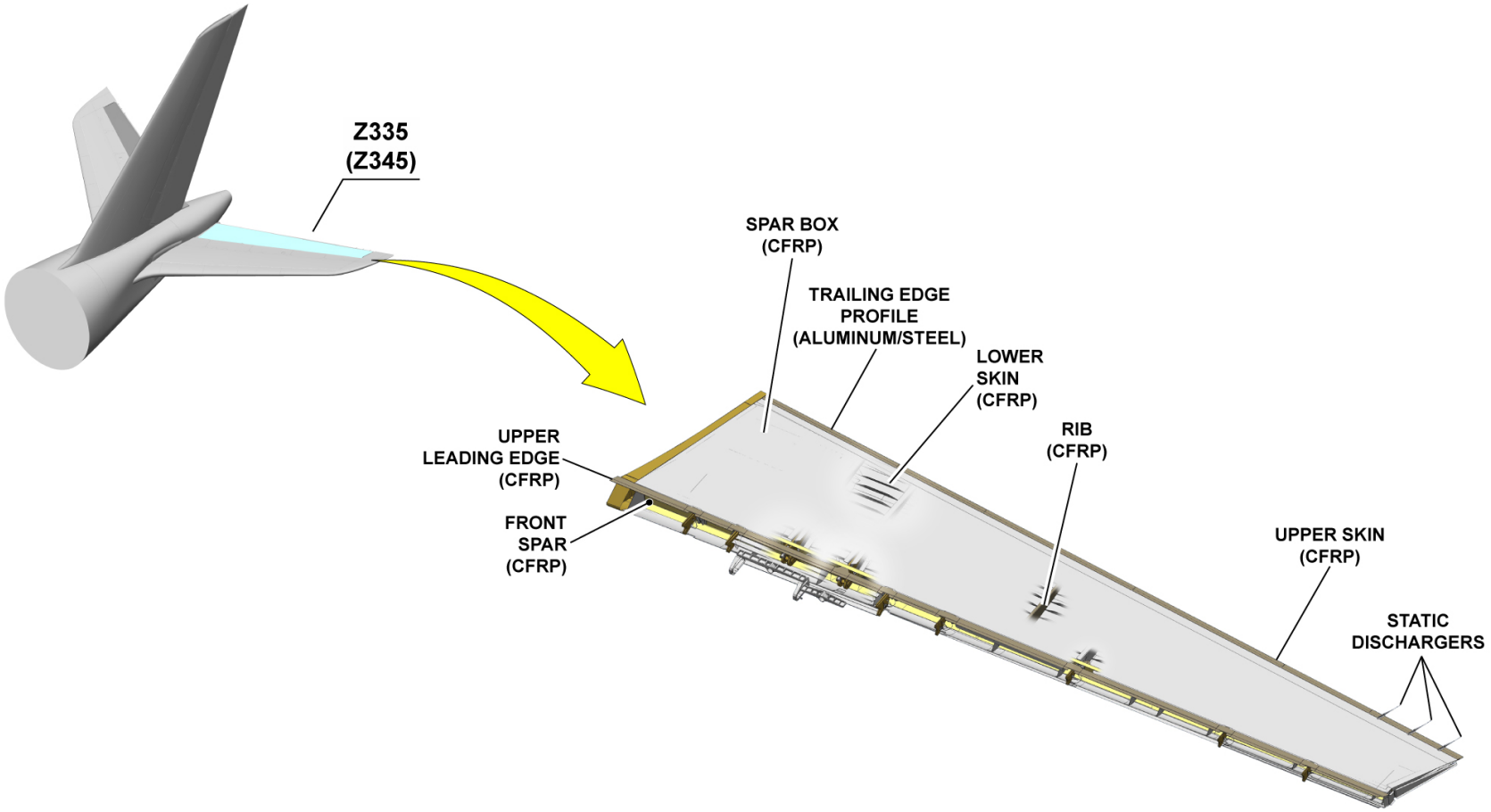
V2414251 - V00T0MM0 - VM51D4STABS3001

STABILIZERS DESCRIPTION (3)

Elevators - Structure Layout

The elevator spar box is the primary structural component of the left and right elevators. All other components of the elevator are attached to the elevator spar box.
The primary components of the elevator spar box are:
- Spars
- Ribs
- Skin
- TE profiles.

All components are made of CFRP. The TE profiles are made of aluminum alloy. The TE profiles are attached to the skin copper mesh for protection from the lightning strike.



ELEVATORS - STRUCTURE LAYOUT

V2414251 - V00T0MM0 - VM51D4STABS3001

STABILIZERS DESCRIPTION (3)

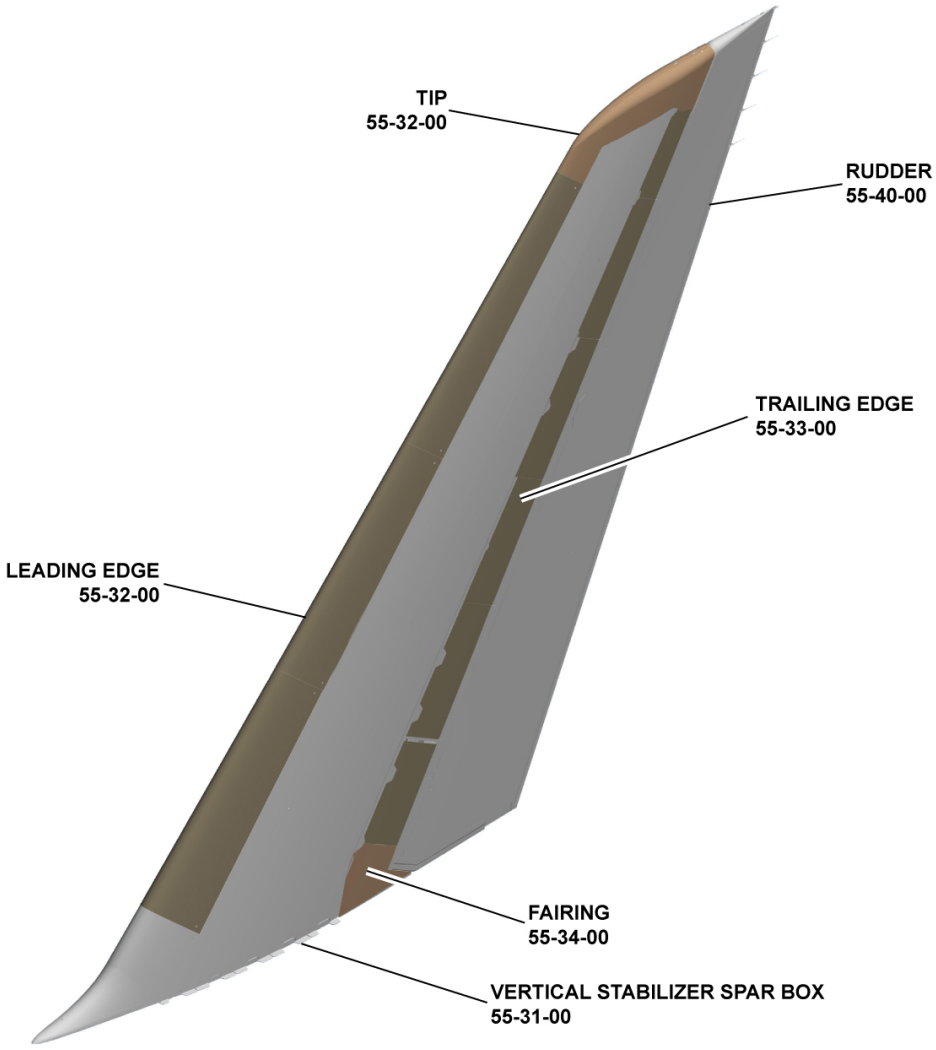
Vertical Stabilizer

General Arrangement

The vertical stabilizer is attached to the top of the rear fuselage. It holds the rudder which is operated by three servo control units. The High Frequency (HF) antenna and the Very High Frequency (VHF) Omnidirectional Range (VOR) antenna are installed on the top of the rear fuselage.

The primary components of the vertical stabilizer are:

- The spar box
- The LE
- The TE
- The Tip.



VERTICAL STABILIZER - GENERAL ARRANGEMENT

V2414251 - V00T0MM0 - VM51D4STABS3001

STABILIZERS DESCRIPTION (3)

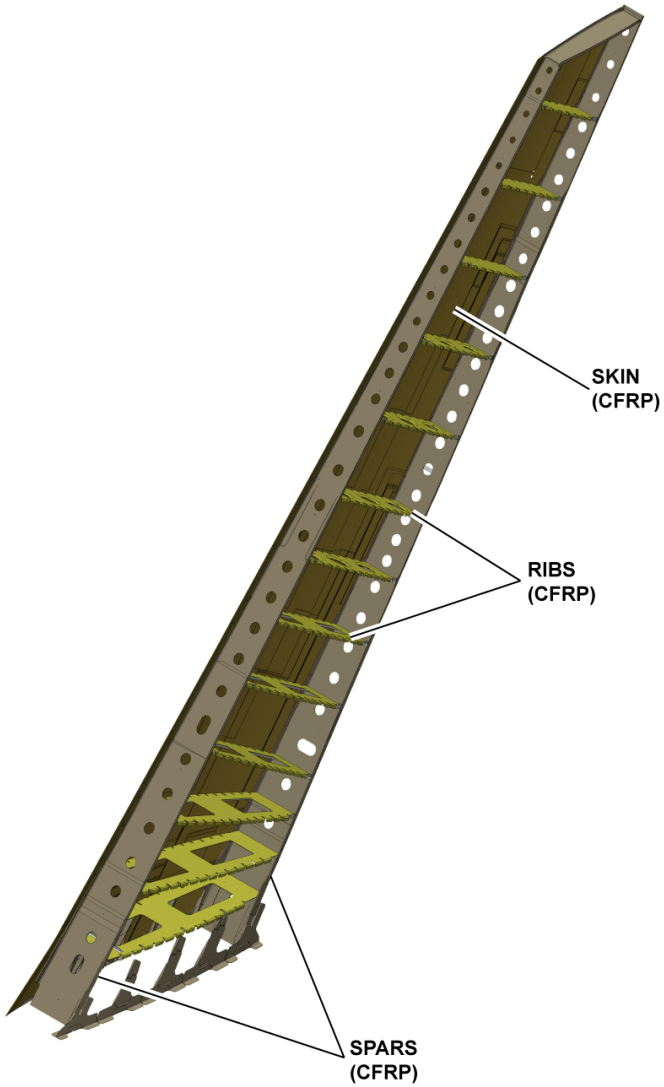
Vertical Stabilizer (continued)

Spar Box

The spar box is the primary structural component of the vertical stabilizer. All other primary components of the vertical stabilizer are attached to the spar box.
The primary components of the spar box are:
- The front and rear spars
- The ribs
- The side panels with integrated stiffeners.

All these components are made of CFRP.

V2414251 - V00T0MM0 - VM51D4STABS3001



VERTICAL STABILIZER - SPAR BOX

STABILIZERS DESCRIPTION (3)

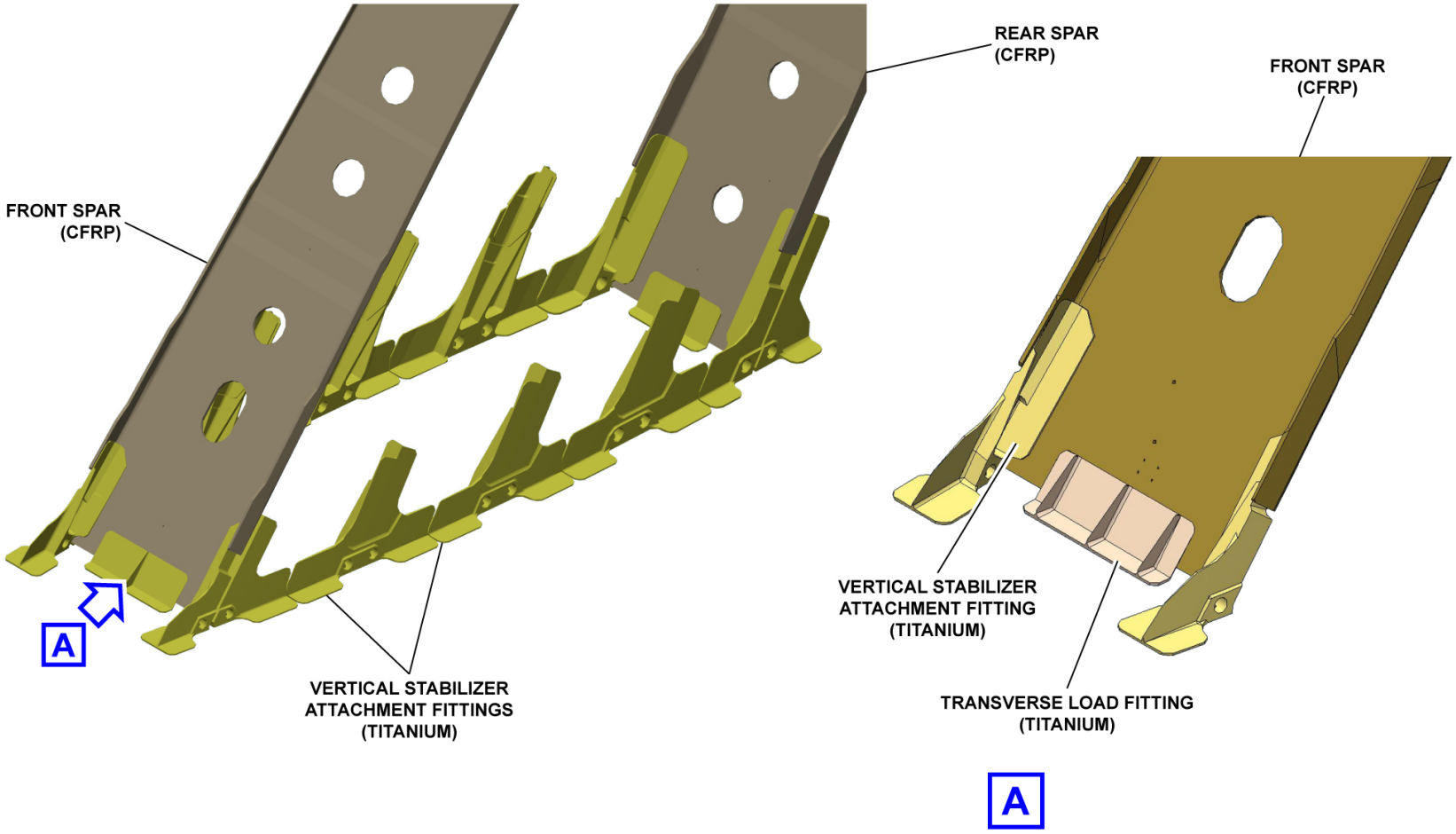
Vertical Stabilizer (continued)

Fuselage Attachment

The vertical stabilizer has vertical stabilizer attachment-fittings (tension shear fittings). They are made of titanium and are attached to the lower end of the skin panels (the skin, the stringers, the flanges and vertical stabilizer attachment-fittings are one unit). The vertical stabilizer attachment-fittings are installed from the front spar to the rear spar.

The two transverse load fittings (spar fittings) are made of titanium. They are attached to the lower end of the front and the rear spar. The transverse load fittings transmit the transverse loads of the vertical stabilizer to the fuselage.

V2414251 - V00T0MM0 - VM51D4STABS3001



VERTICAL STABILIZER - FUSELAGE ATTACHMENT

V2414251 - V00T0MM0 - VM51D4STABS3001

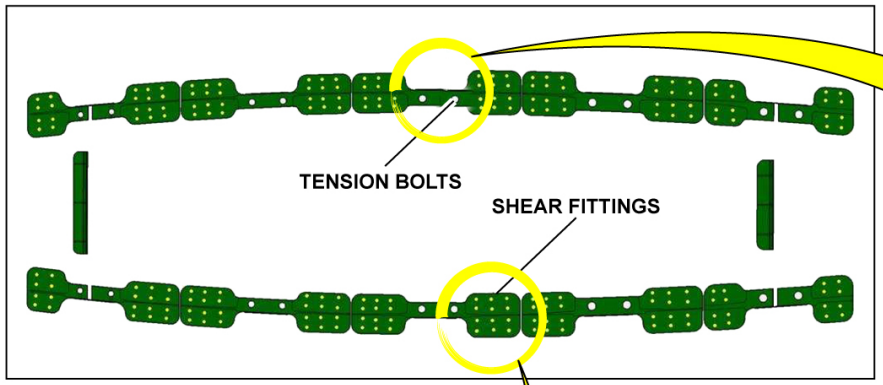
STABILIZERS DESCRIPTION (3)

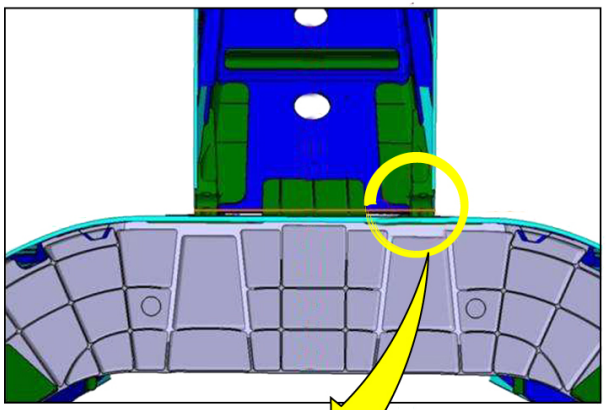
Vertical Stabilizer (continued)

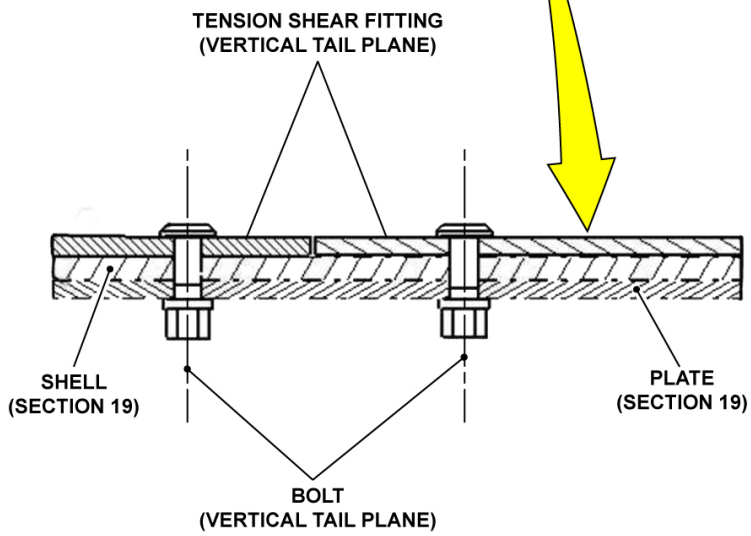
Spar Box Attachment

Twenty (20) bolts, barrel nuts and retainers connect the vertical spar box to the aircraft structure.

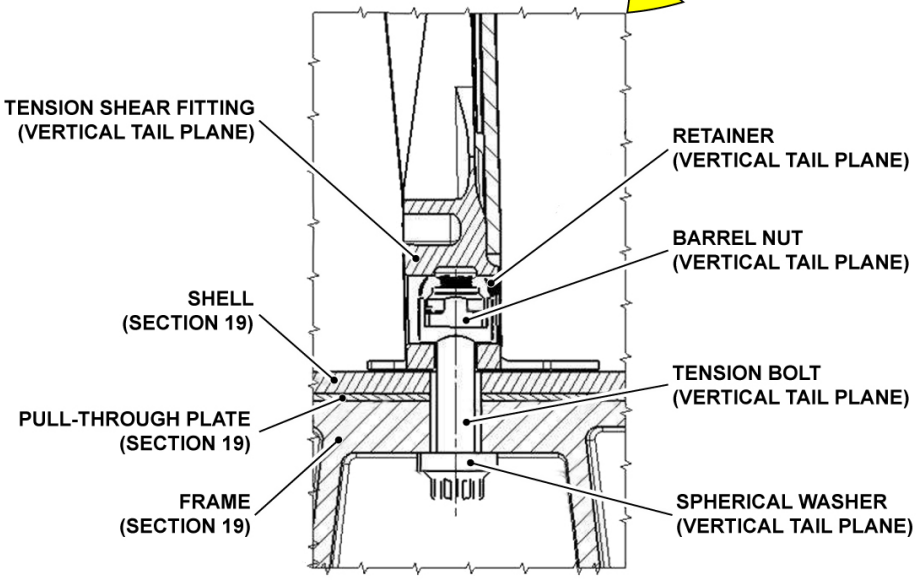
V2414251 - V00T0MM0 - VM51D4STABS3001







SHEAR FITTING, TYPICAL ATTACHMENT



TENSION BOLT, TYPICAL ATTACHMENT

VERTICAL STABILIZER - SPAR BOX ATTACHMENT

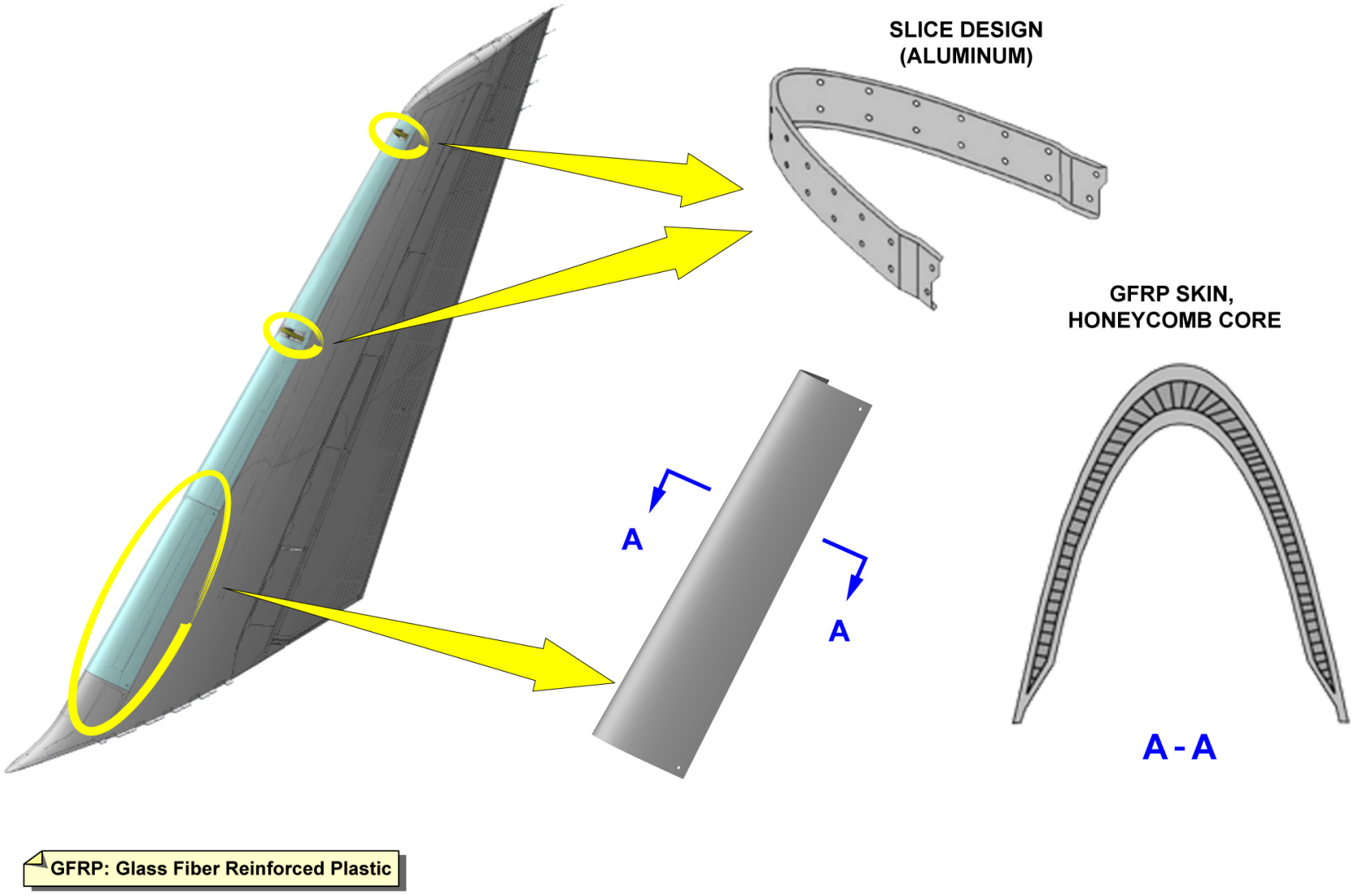
STABILIZERS DESCRIPTION (3)

Vertical Stabilizer (continued)

Leading Edge (LE)

The vertical stabilizer LE gives an aerodynamic shape to the front of the vertical stabilizer. The vertical stabilizer LE has removable sections. They are attached to the forward edge of the spar-box side panels and to the LE ribs. It gives protection against damage to the structural parts, the HF antenna and the ETACS camera. The LE sections are made of GFRP sandwich construction.

V2414251 - V00T0MM0 - VM51D4STABS3001



VERTICAL STABILIZER - LEADING EDGE (LE)

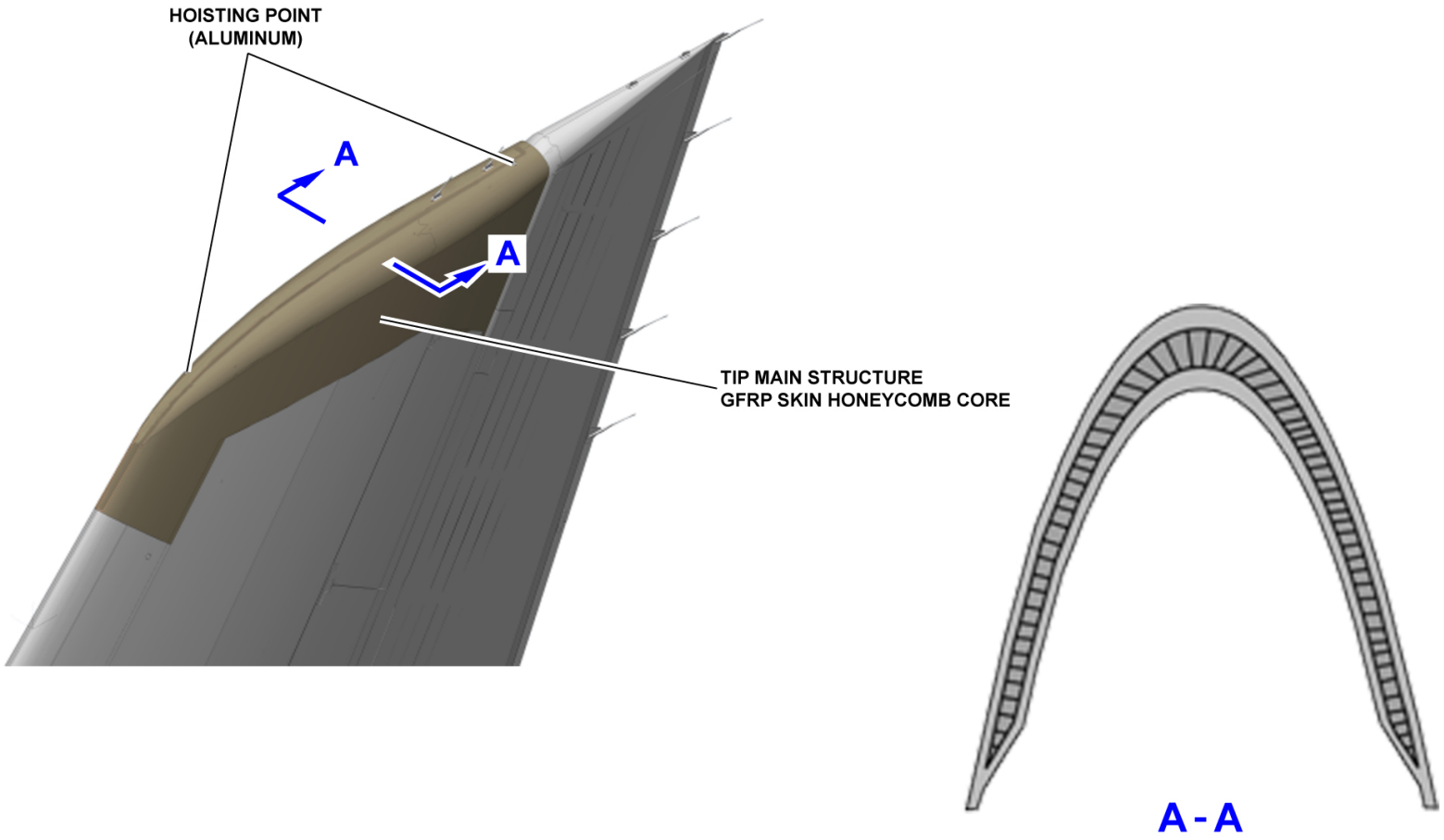
STABILIZERS DESCRIPTION (3)

Vertical Stabilizer (continued)

Tip

The tip is the upper fairing of the vertical stabilizer. It is attached to the top of the spar box and to the front spar. It is made of GFRP skin bonded to a honeycomb core.

V2414251 - V00T0MM0 - VM51D4STABS3001



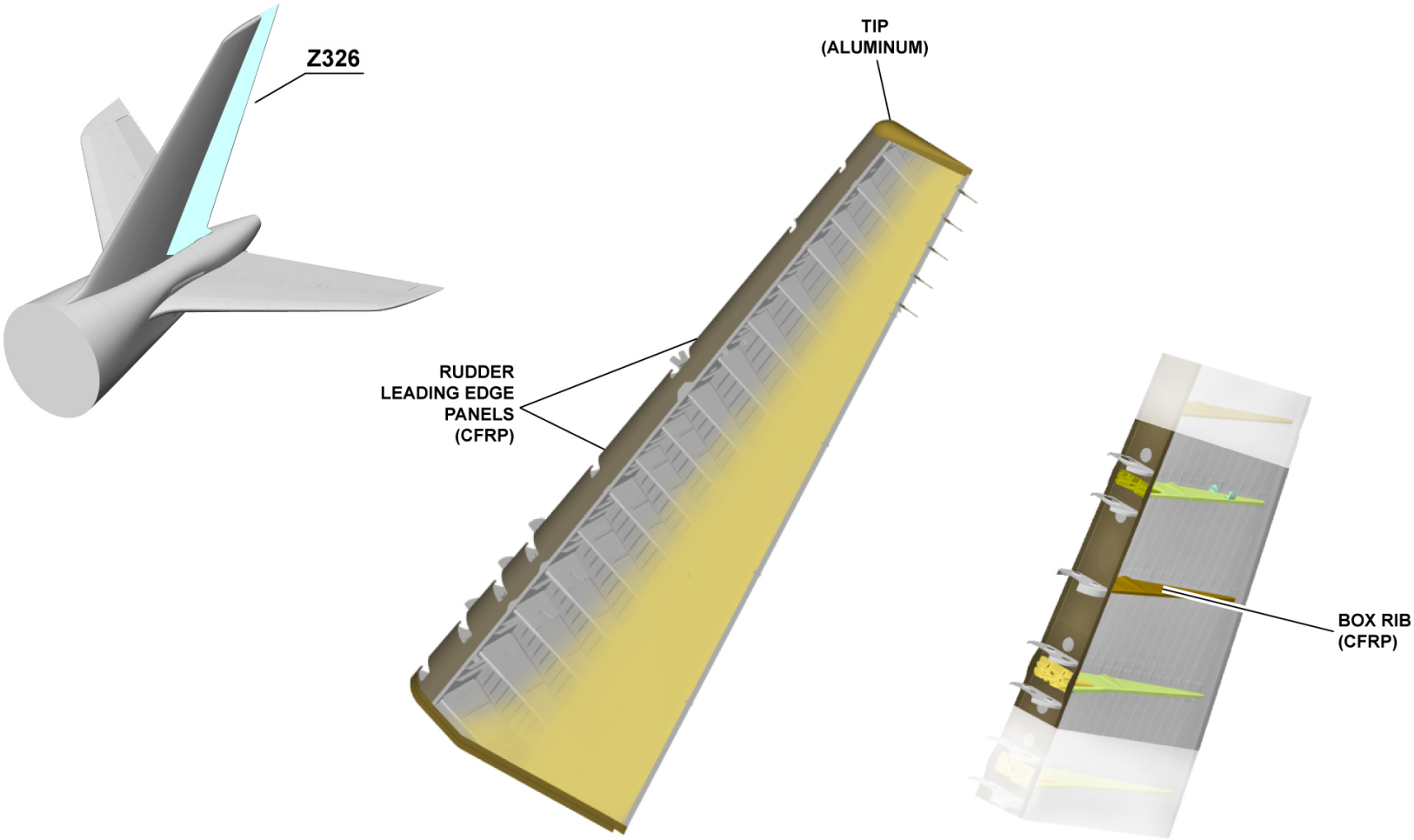
VERTICAL STABILIZER - TIP

STABILIZERS DESCRIPTION (3)

Rudder

The primary components of the rudder are:
- The main structure
- LE panels and ribs made of CFRP
- An aluminum alloy tip.

The rudder main structure is the primary structural component of the rudder.
It has an assembly of:
- Two skin panels made of CFRP sandwich construction
- A carbon fiber front spar
- A bottom carbon fiber closing rib
- A top carbon fiber closing rib.


Z326
TIP
(ALUMINUM)
RUDDER
LEADING EDGE
PANELS
(CFRP)
BOX RIB
(CFRP)

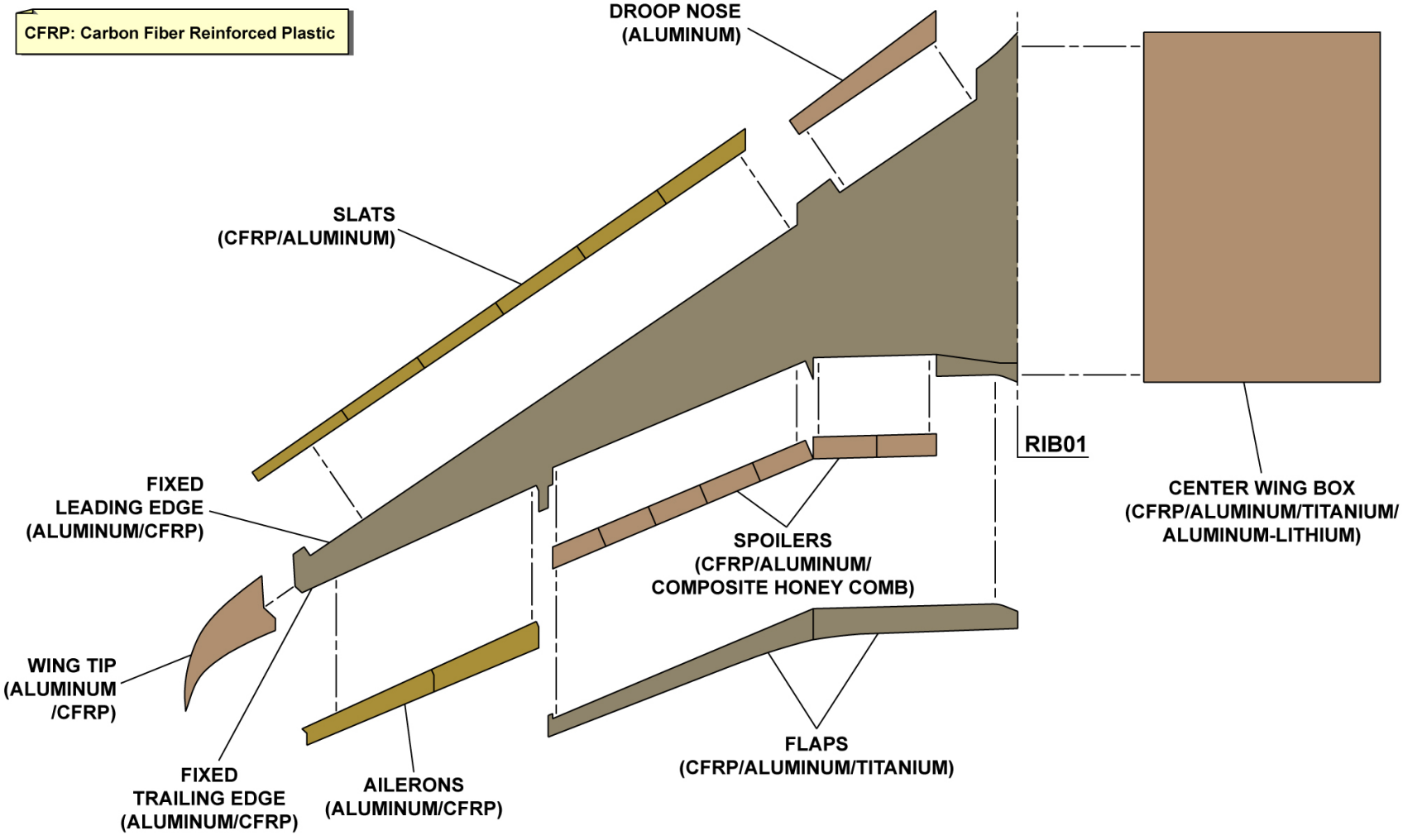
RUDDER

WINGS DESCRIPTION (3)

General

The aircraft wing is a continuous structure which goes through the fuselage. The aircraft wing is divided into three parts:
- Center wing
- Left outer wing
- Right outer wing.

The center wing box has cantilever attachment for the outer wings and transmits the loads to the fuselage structure.



GENERAL

V2414251 - V00T0MM0 - VM51D5WINGS3001

WINGS DESCRIPTION (3)

Center Wing Box

General Arrangement

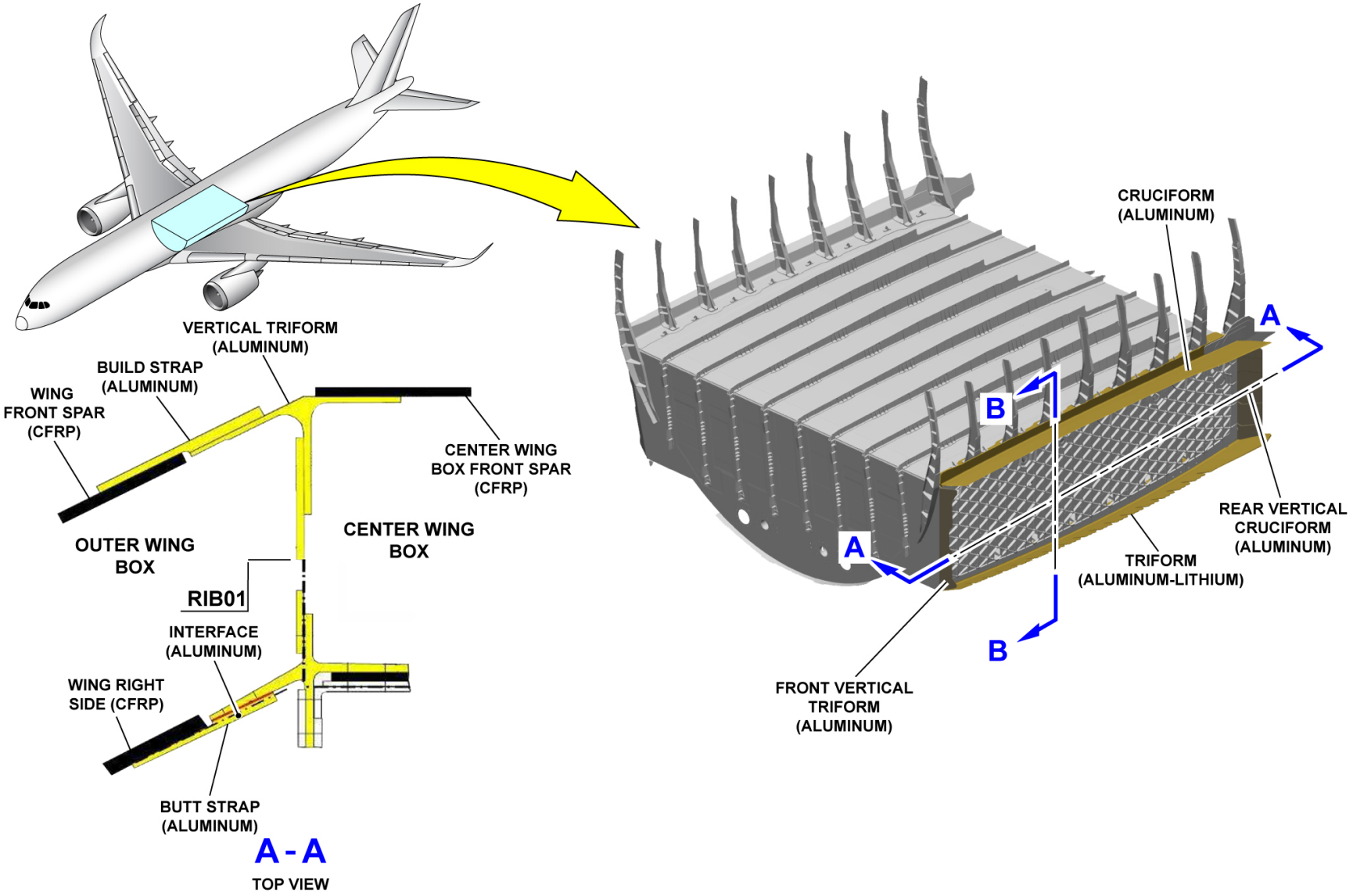
The center wing is installed in the center fuselage and makes an integral fuel tank.
The center wing box structure includes:
- Front and rear spars respectively (Carbon Fiber Reinforced Plastic (CFRP)
- Top and bottom skin panels (CFRP)
- Two main frames (aluminum-lithium)
- Internal carbon-fiber rods (CFRP)
- Longitudinal beams (aluminum alloy).

Wing Root Joint

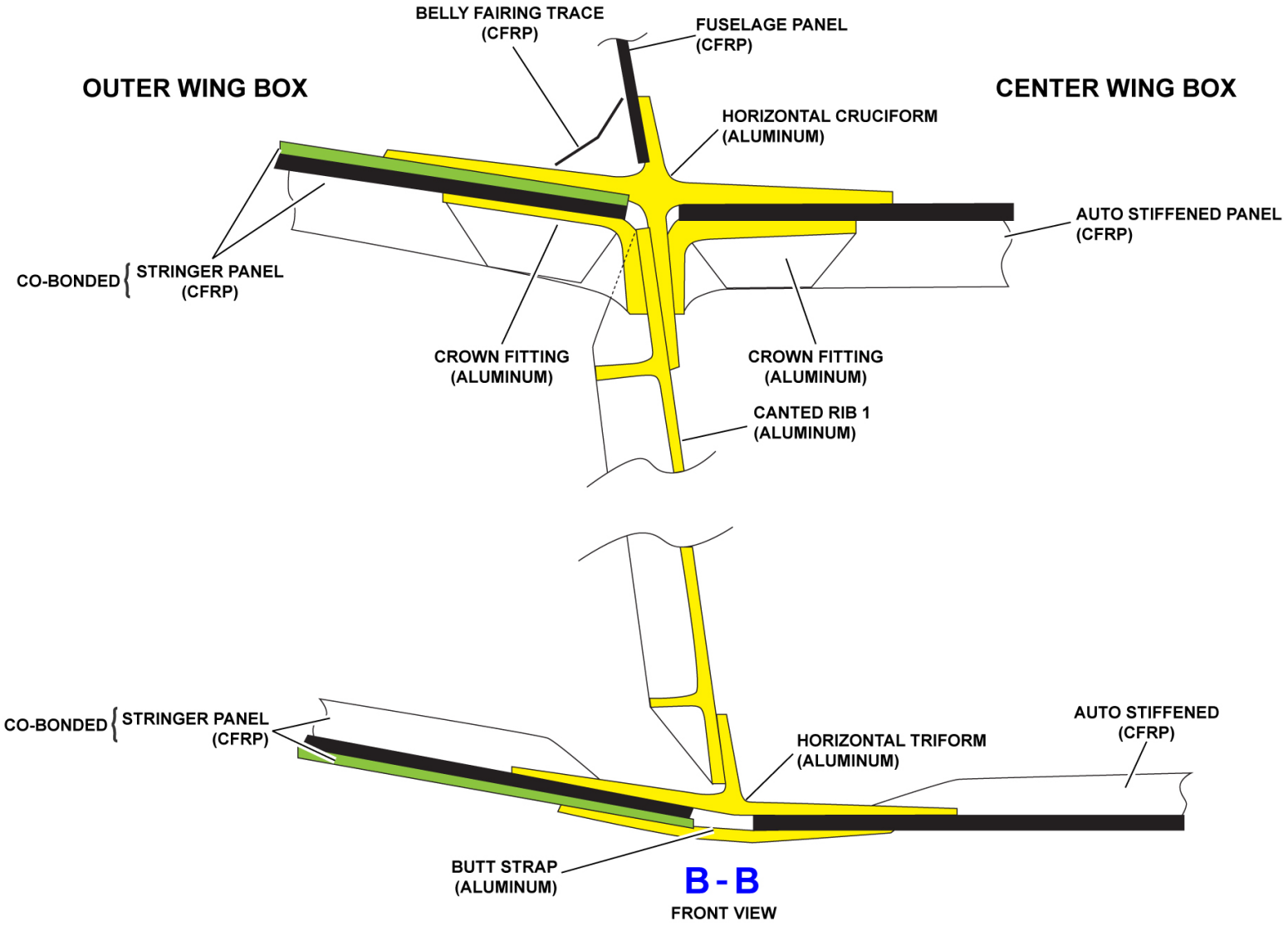
The outer wing boxes are connected to the center wing box at Rib1.
An upper cruciform fitting makes the junction between:
- The center wing box and the outer wing box top skin panels
- Fuselage and Rib1.

A lower triform fitting makes the junction between center wing box panels, bottom skin panels of the outer wing box and the Rib1.

V2414251 - V00T0MM0 - VM51D5WINGS3001



CENTER WING BOX - GENERAL ARRANGEMENT & WING ROOT JOINT



CENTER WING BOX - GENERAL ARRANGEMENT & WING ROOT JOINT

V2414251 - V00T0MM0 - VM51D5WINGS3001

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WINGS DESCRIPTION (3)

Outer Wing Box

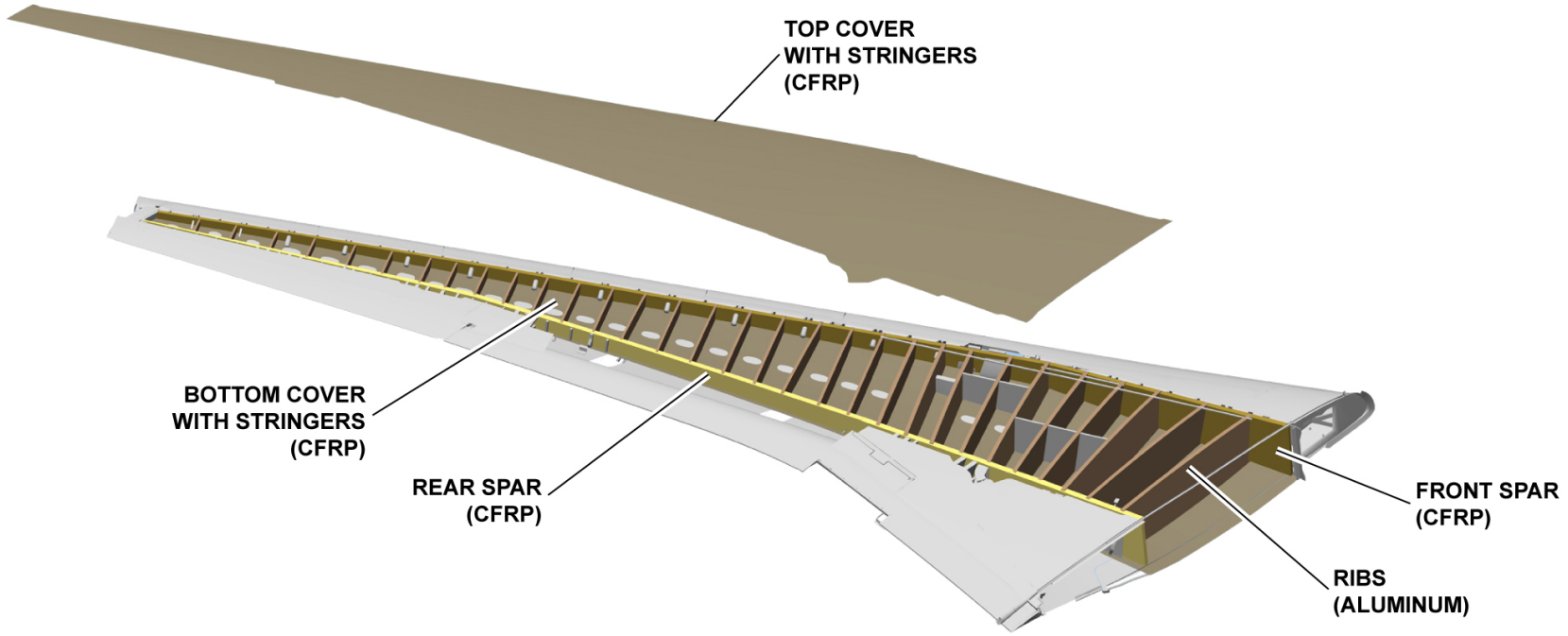
General Arrangement

The wing box tapers and includes:
- Wing spars (front and rear)
- Ribs
- Top and bottom skin panels
- Top and bottom stringers.

Structure Layout

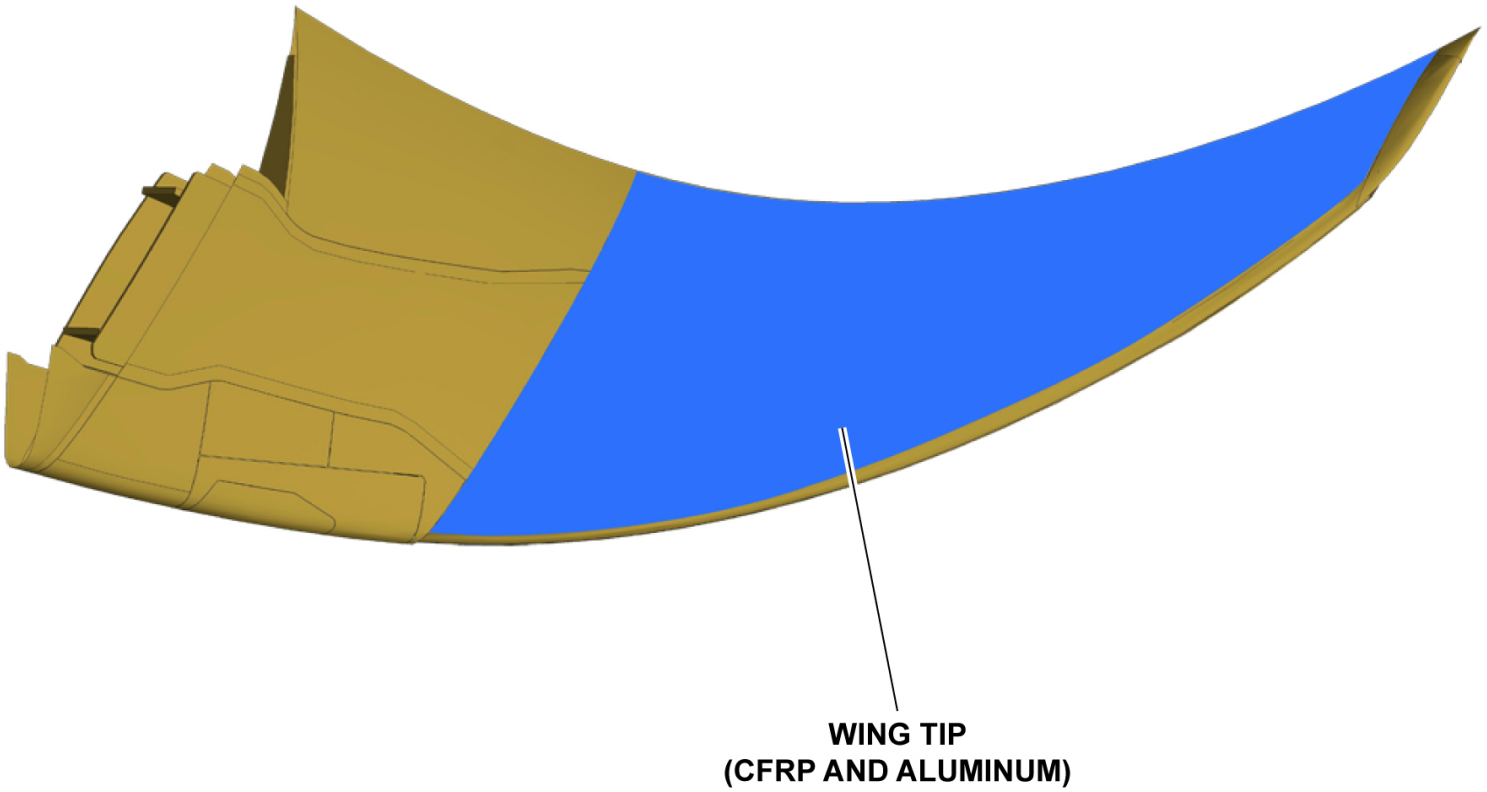
The top and bottom covers of the outer wing box are made of composite material (CFRP).
The top cover has no access holes, thus it is a solid surface. There are twenty seven access holes in the bottom cover that gives access into the wing-box fuel tanks. To make the bottom cover stronger, skin is thicker around the access holes. Stringers are attached to the top and bottom covers. They are made of composite material (CFRP) and give the covers more strength. They are installed from inboard to outboard direction.
The wing spars are made of composite materials (CFRP) and gives the strength to the wing box.
There are thirty three ribs in the wing box of each outer wing (aluminum alloy).
Each wing has a tip made of CFRP and aluminum.

V2414251 - V00T0MM0 - VM51D5WINGS3001



OUTER WING BOX - GENERAL ARRANGEMENT & STRUCTURE LAYOUT

V2414251 - V00T0MM0 - VM51D5WINGS3001



OUTER WING BOX - GENERAL ARRANGEMENT & STRUCTURE LAYOUT

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V2414251 - V00T0MM0 - VM51D5WINGS3001

WINGS DESCRIPTION (3)

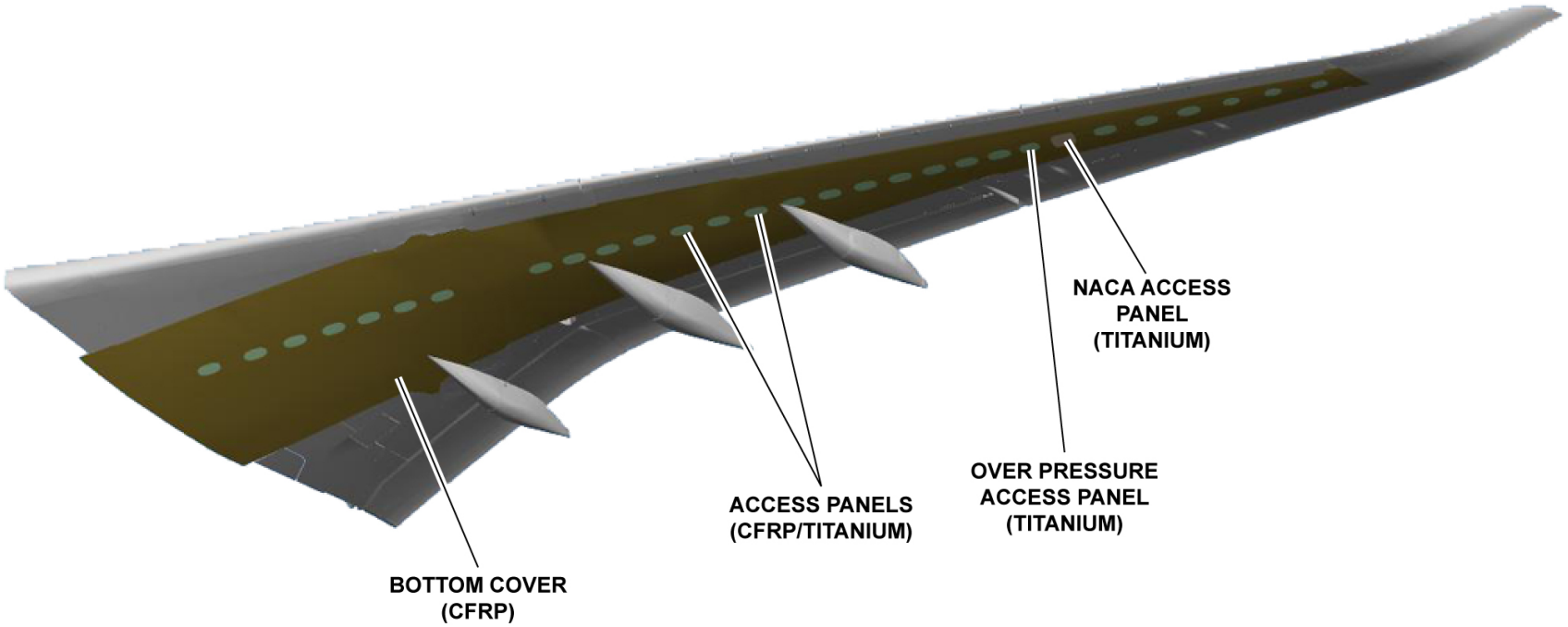
Outer Wing Box (continued)

Access Holes / Covers

There are access covers (panels) installed in the bottom skin panels of the wing box.
All the access panels close the openings that give access to the wing box.
The bolts and the clamp rings attach the access panels to the bottom cover of the wing.
The access panels are made of composite material (CFRP / titanium).

NOTE: Torque the access cover bolts correctly in a symmetrical diagonal pattern to prevent leaks.

V2414251 - V00T0MM0 - VM51D5WINGS3001



OUTER WING BOX - ACCESS HOLES / COVERS

V2414251 - V00T0MM0 - VM51D5WINGS3001

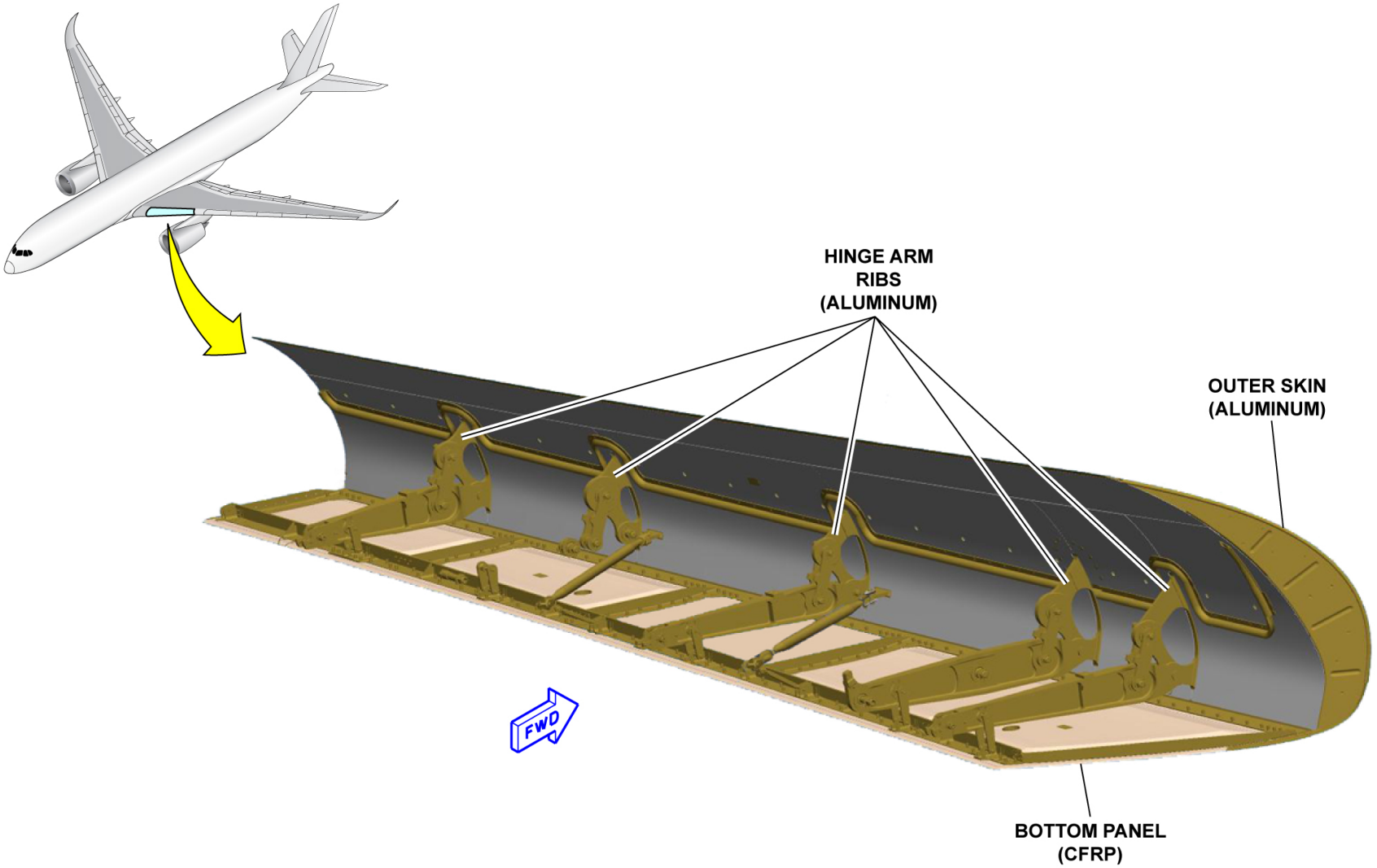
WINGS DESCRIPTION (3)

Slats

Droop Nose (Slat 1)

The droop nose is installed between the pylon fixed structure (inboard side) and the bath tub assembly. Metallic hinge ribs attach each droop nose to the fixed LE.
The droop nose has:
- An aerodynamic seal installed on the inner skin panel
- Hinge arm ribs
- A composite bottom panel
- An outer metallic top skin (aluminum).

V2414251 - V00T0MM0 - VM51D5WINGS3001



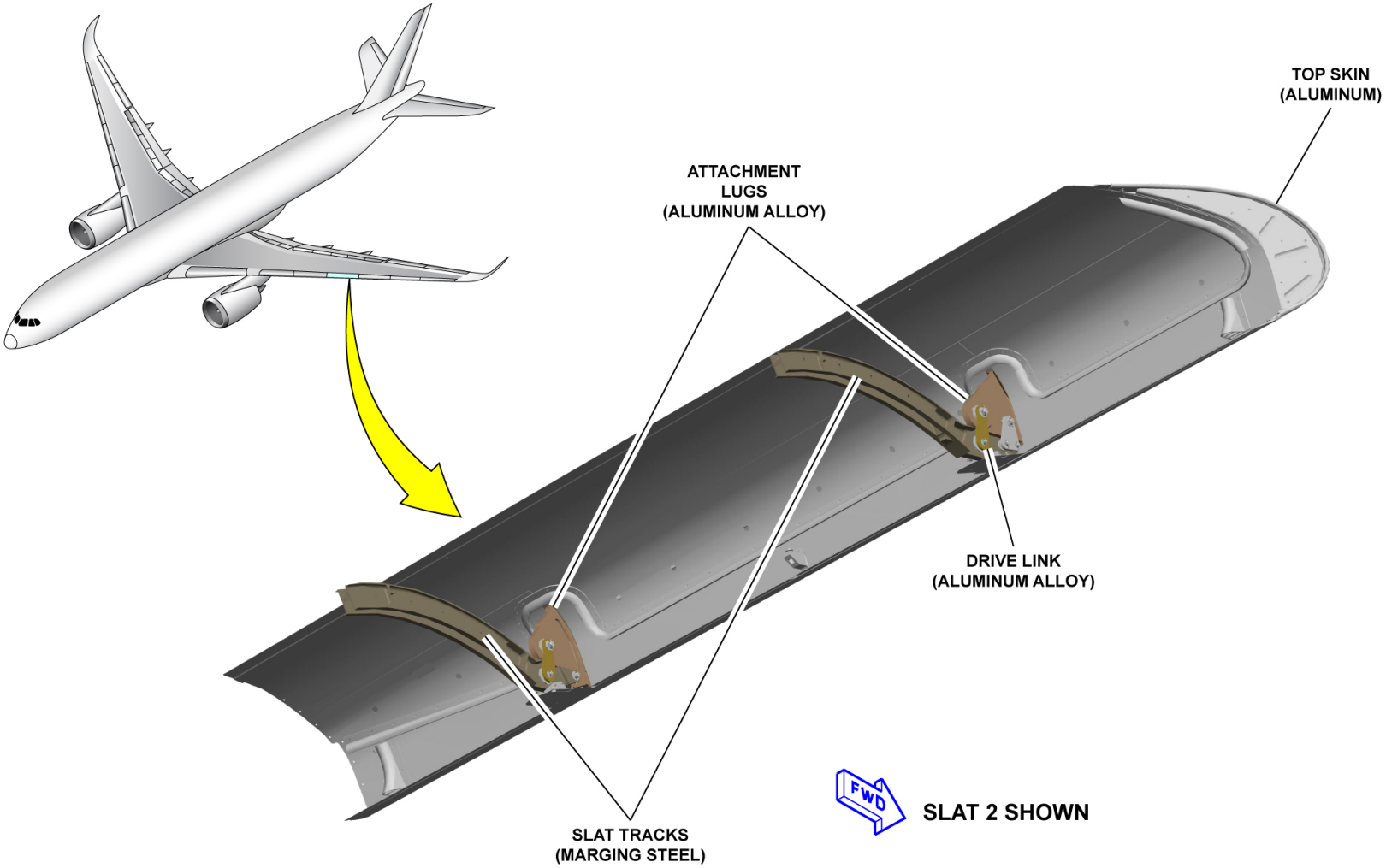
SLATS - DROOP NOSE (SLAT 1)

WINGS DESCRIPTION (3)

Slats (continued)

Slats 2 to 7

Slats two to seven are installed between the pylon fixed structure (outboard side) and the wing tip. The slats have metallic top skin and are attached to their tracks with metallic drive links.
Slats two to five have a metallic design.
Slats six and seven have a composite and metallic box structure (aluminum alloy).



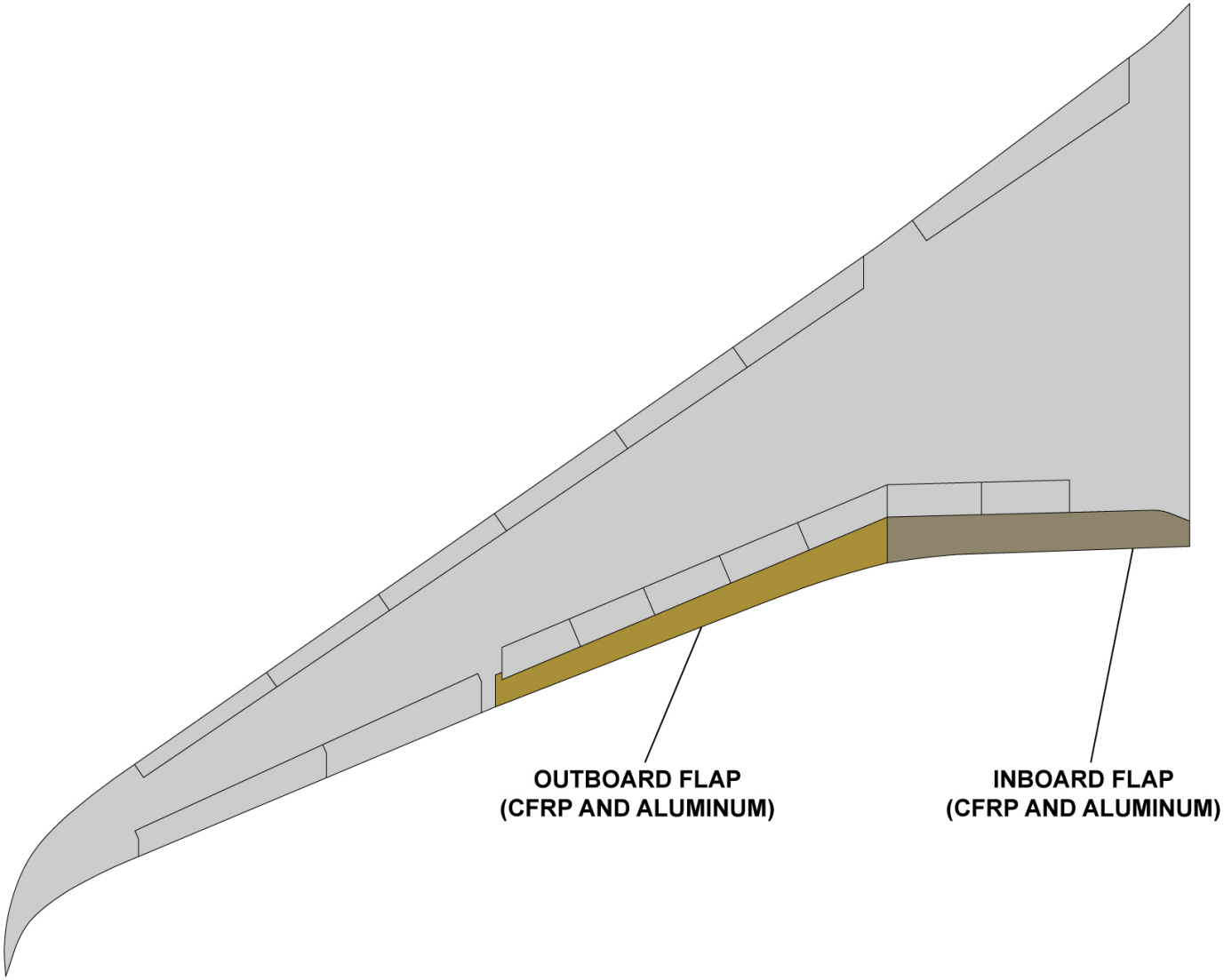
SLATS - SLATS 2 TO 7

WINGS DESCRIPTION (3)

Trailing Edge (TE) Devices

Flaps - General Arrangement

Two single-element flaps are installed on the TE of the outer wing (CFRP and aluminum).



TRAILING EDGE (TE) DEVICES - FLAPS - GENERAL ARRANGEMENT

V2414251 - V00T0MM0 - VM51D5WINGS3001

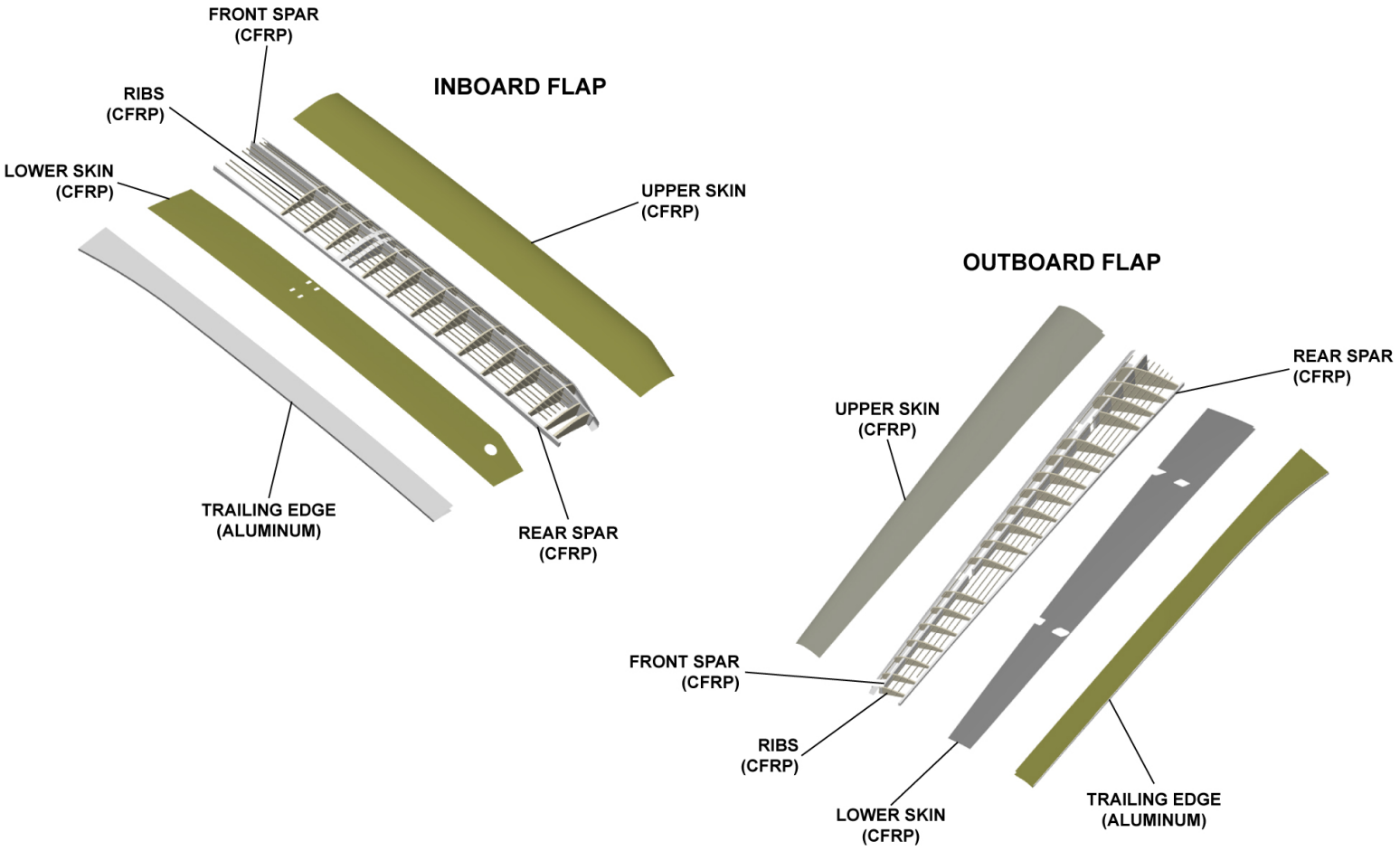
WINGS DESCRIPTION (3)

Trailing Edge (TE) Devices (continued)

Flap Structure

The flap structure is made of standard aluminum alloy construction with an aluminum TE.
The outer flap has a main box structure, a carbon fiber LE and a segmented aluminum TE.

V2414251 - V00T0MM0 - VM51D5WINGS3001



TRAILING EDGE (TE) DEVICES - FLAP STRUCTURE

V2414251 - V00T0MM0 - VM51D5WINGS3001

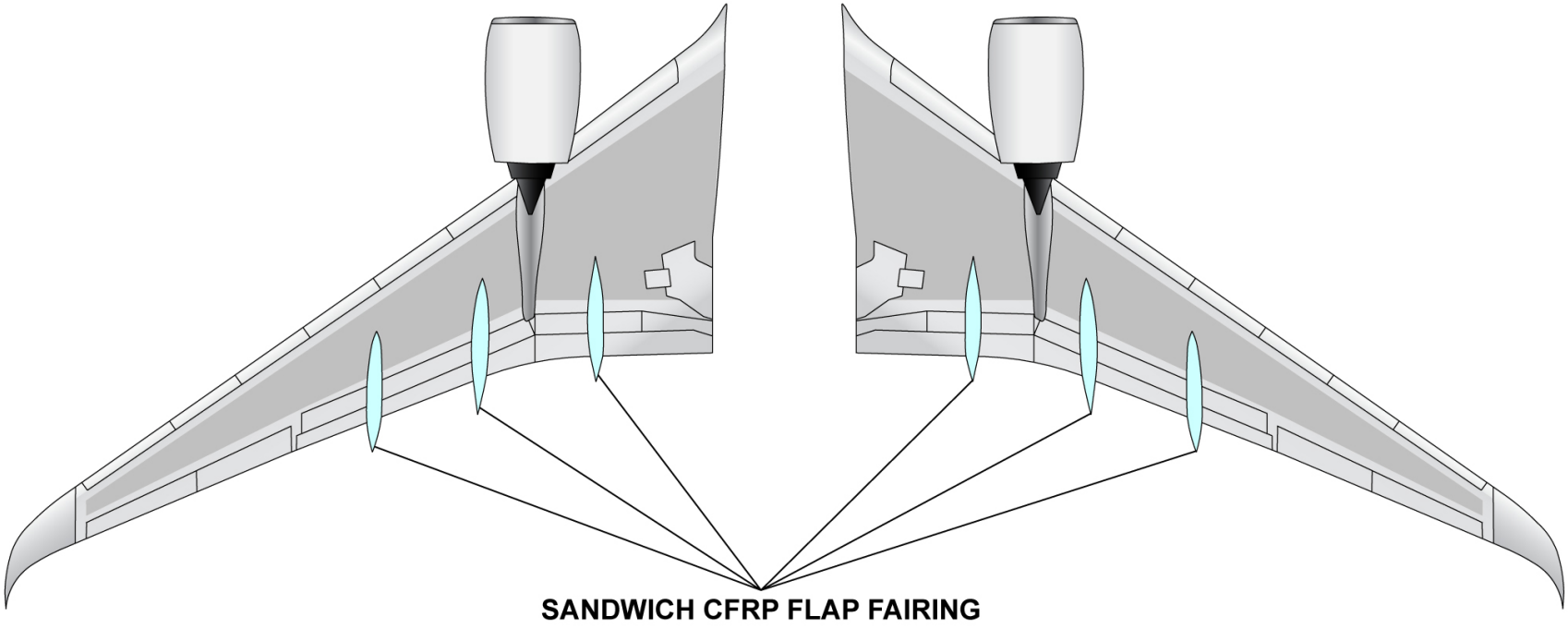
WINGS DESCRIPTION (3)

Trailing Edge (TE) Devices (continued)

Flap Actuator Fairings

Flap actuator fairings are made of sandwich CFRP.

V2414251 - V00T0MM0 - VM51D5WINGS3001



TRAILING EDGE (TE) DEVICES - FLAP ACTUATOR FAIRINGS

V2414251 - V00T0MM0 - VM51D5WINGS3001

WINGS DESCRIPTION (3)

Trailing Edge (TE) Devices (continued)

Spoilers - General Arrangement

There are seven spoilers installed in the upper surface of the TE of each wing.

Spoilers - Structure Layout

The spoilers have a wedge-shaped structure. Top and bottom skins are made of CFRP. They are bonded to a honeycomb core.

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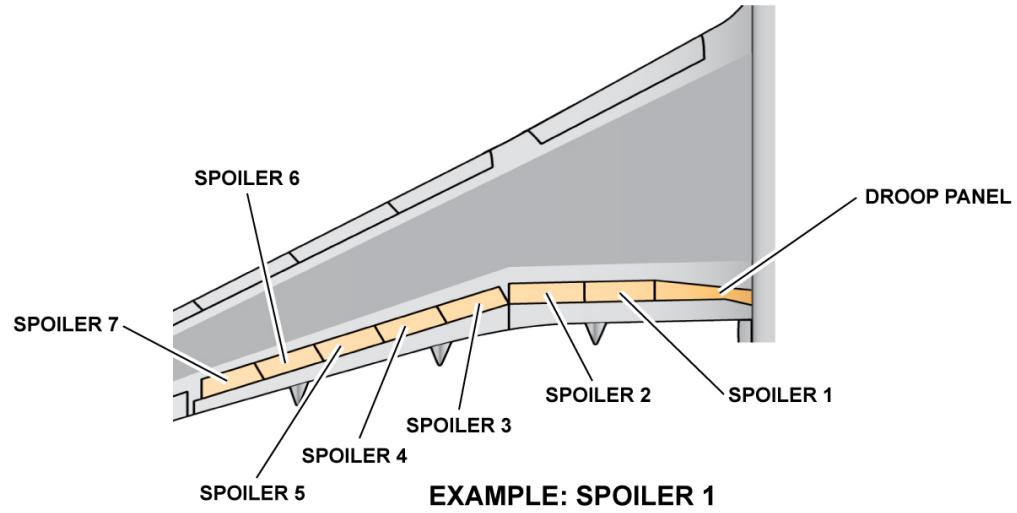

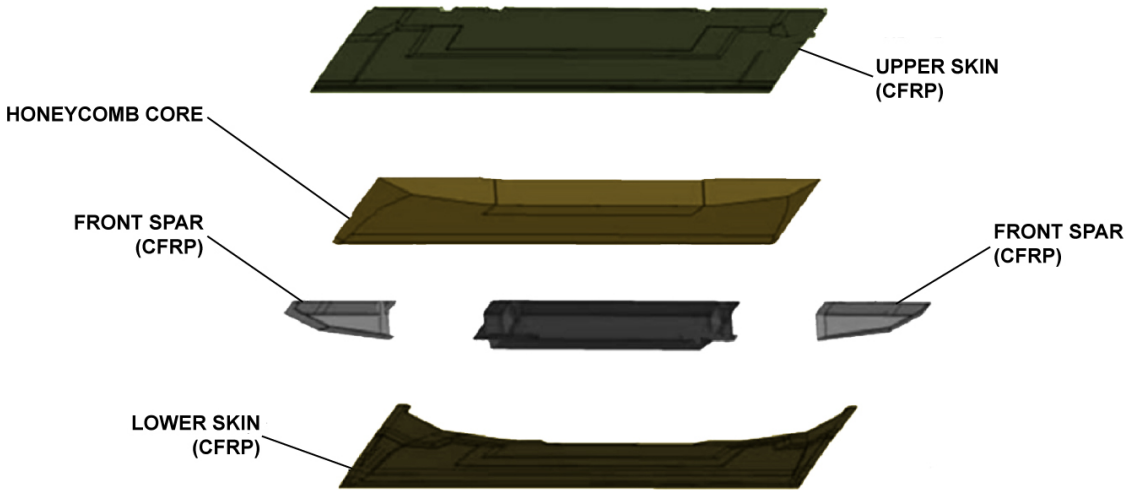

TRAILING EDGE (TE) DEVICES - SPOILERS - GENERAL ARRANGEMENT & SPOILERS - STRUCTURE LAYOUT

WINGS DESCRIPTION (3)

Trailing Edge (TE) Devices (continued)

Ailerons - Structure Layout

The ailerons are installed at the end of the wings. The box structure has these parts:

- The lower and an upper CFRP sandwich panel, with monolithic areas at the rib and spar attachments
- The spar assembly: spar and center hinge fitting are CFRP and actuator fitting is aluminum.
- Ribs assemblies (made of CFRP).

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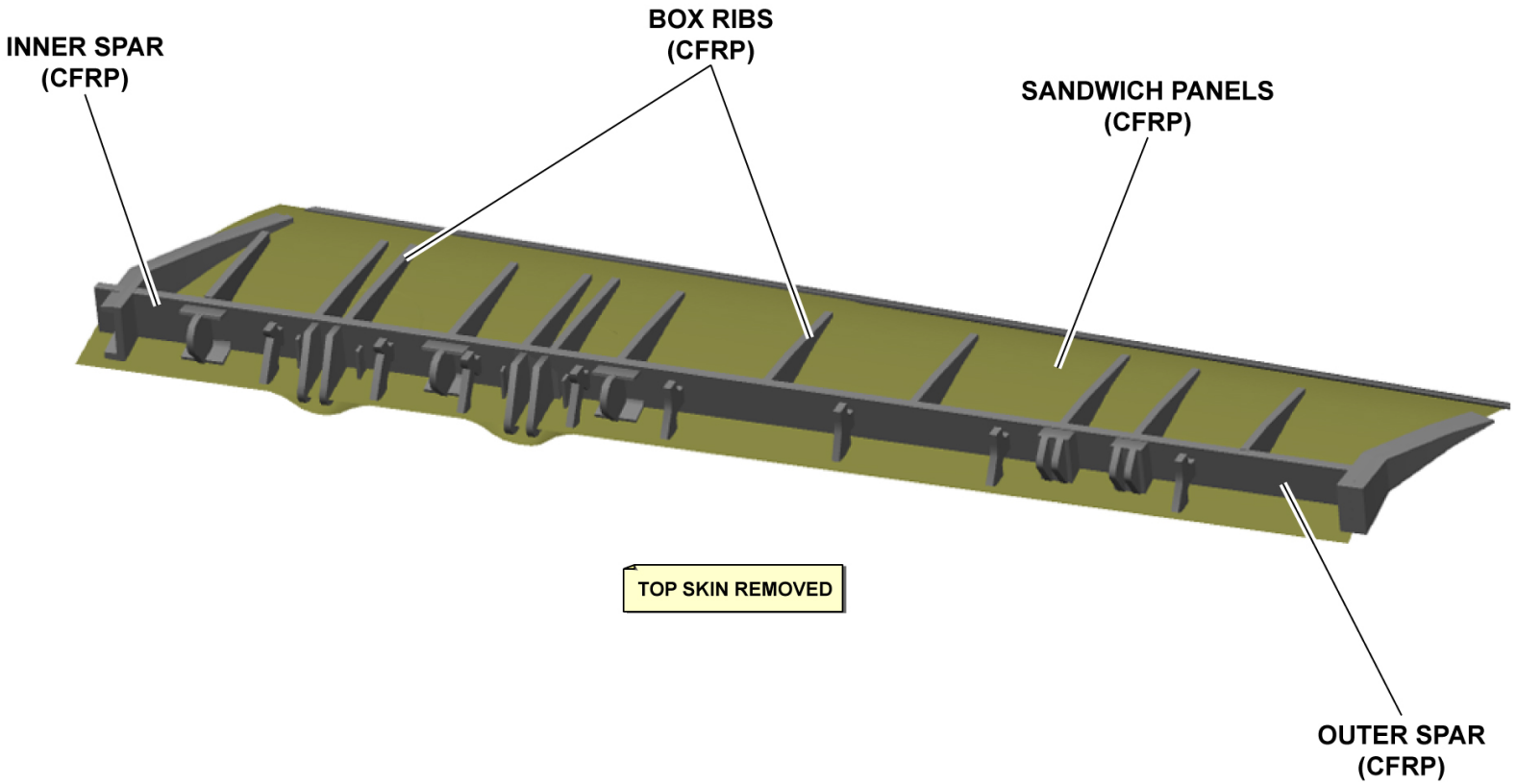

TRAILING EDGE (TE) DEVICES - AILERONS - STRUCTURE LAYOUT

PYLONS AND NACELLES DESCRIPTION (3)

Pylons

The pylons hold the power plant under the wings.
The pylon section has these sub-sections:
- Pylon box (titanium)
- Front pylon fairings (titanium)
- Pylon to wing fairings (Carbon Fiber Reinforced Plastic (CFRP))
- Aft pylon fairings (titanium)
- Rear secondary structure (aluminum or CFRP).

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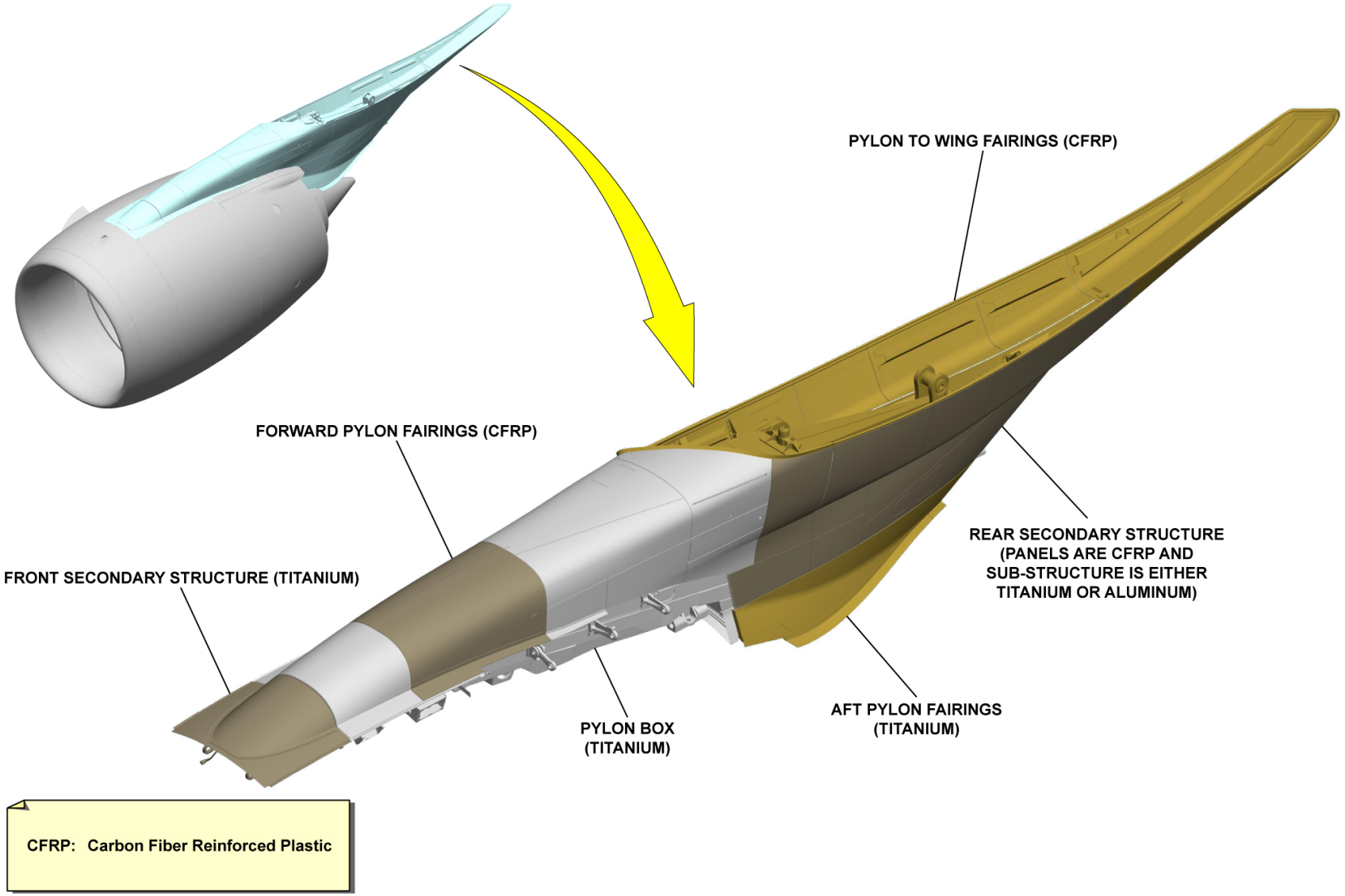

PYLON TO WING FAIRINGS (CFRP)
FORWARD PYLON FAIRINGS (CFRP)
FRONT SECONDARY STRUCTURE (TITANIUM)
REAR SECONDARY STRUCTURE (PANELS ARE CFRP AND SUB-STRUCTURE IS EITHER TITANIUM OR ALUMINUM)
PYLON BOX (TITANIUM)
AFT PYLON FAIRINGS (TITANIUM)
CFRP: Carbon Fiber Reinforced Plastic

PYLONS

PYLONS AND NACELLES DESCRIPTION (3)

Pylons Primary Structure - Pylon Box

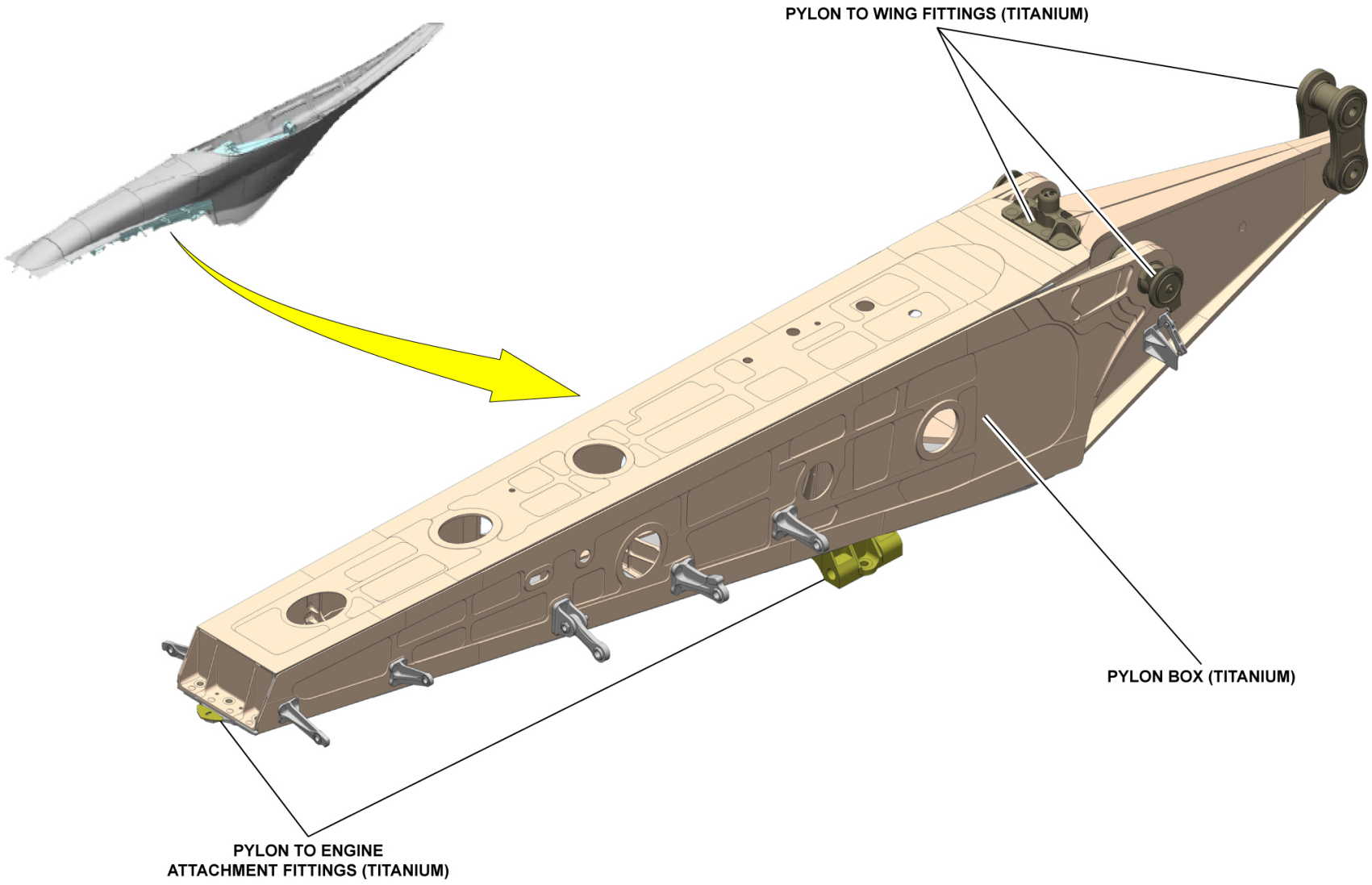
General Arrangement

The pylon box (titanium) is the primary structure. It supports the engine through two points/fittings (titanium) and it is attached to the wing at three points/fittings (titanium). It also transmits the engine thrust to the aircraft.

Pylon to Wing Attachment

The forward attachment transmits axial and vertical loads with attach fittings.

V2414251 - V00T0MM0 - VM51D6PYLON3001



PYLONS PRIMARY STRUCTURE - PYLON BOX - GENERAL ARRANGEMENT & PYLON TO WING ATTACHMENT

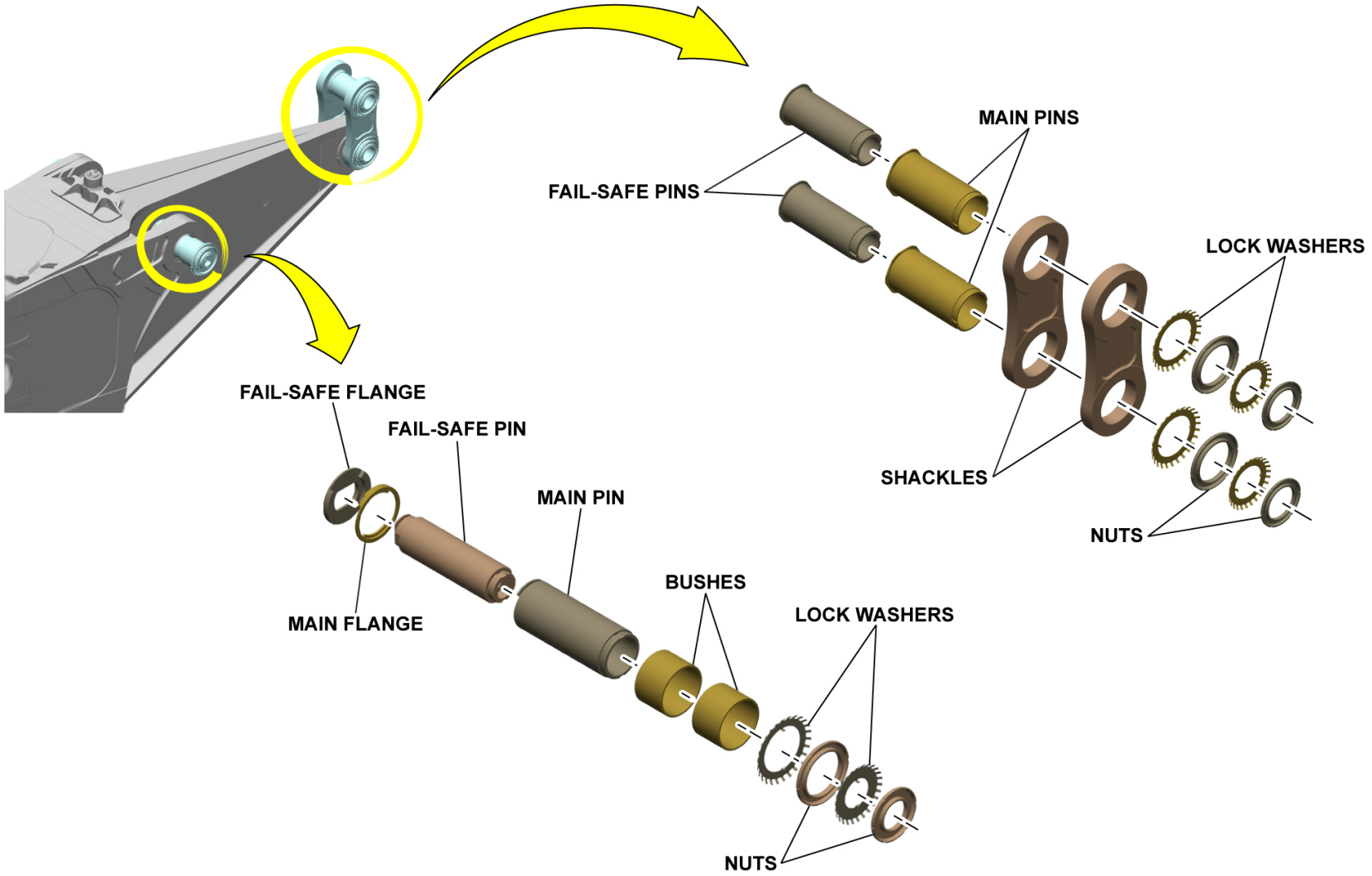
PYLONS AND NACELLES DESCRIPTION (3)

Pylons Primary Structure - Pylon Box (continued)

Pylon Attachment Structure

The aft attachment transmits axial and vertical loads with attach fittings.

V2414251 - V00T0MM0 - VM51D6PYLON3001



PYLONS PRIMARY STRUCTURE - PYLON BOX - PYLON ATTACHMENT STRUCTURE

PYLONS AND NACELLES DESCRIPTION (3)

Nacelles

Fan Cowls

Fan cowls are made of monolithic CFRP.

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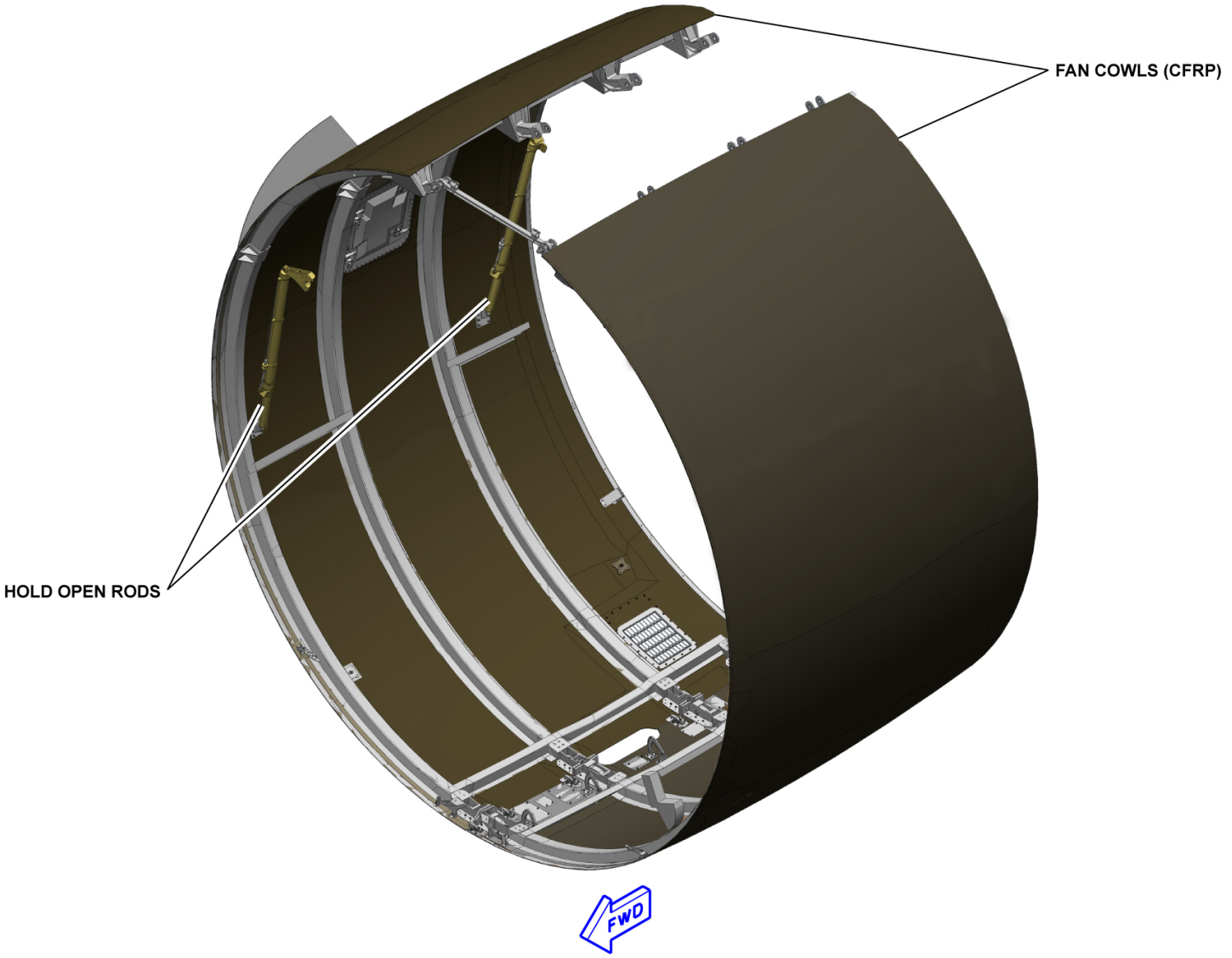


NACELLES - FAN COWLS

PYLONS AND NACELLES DESCRIPTION (3)

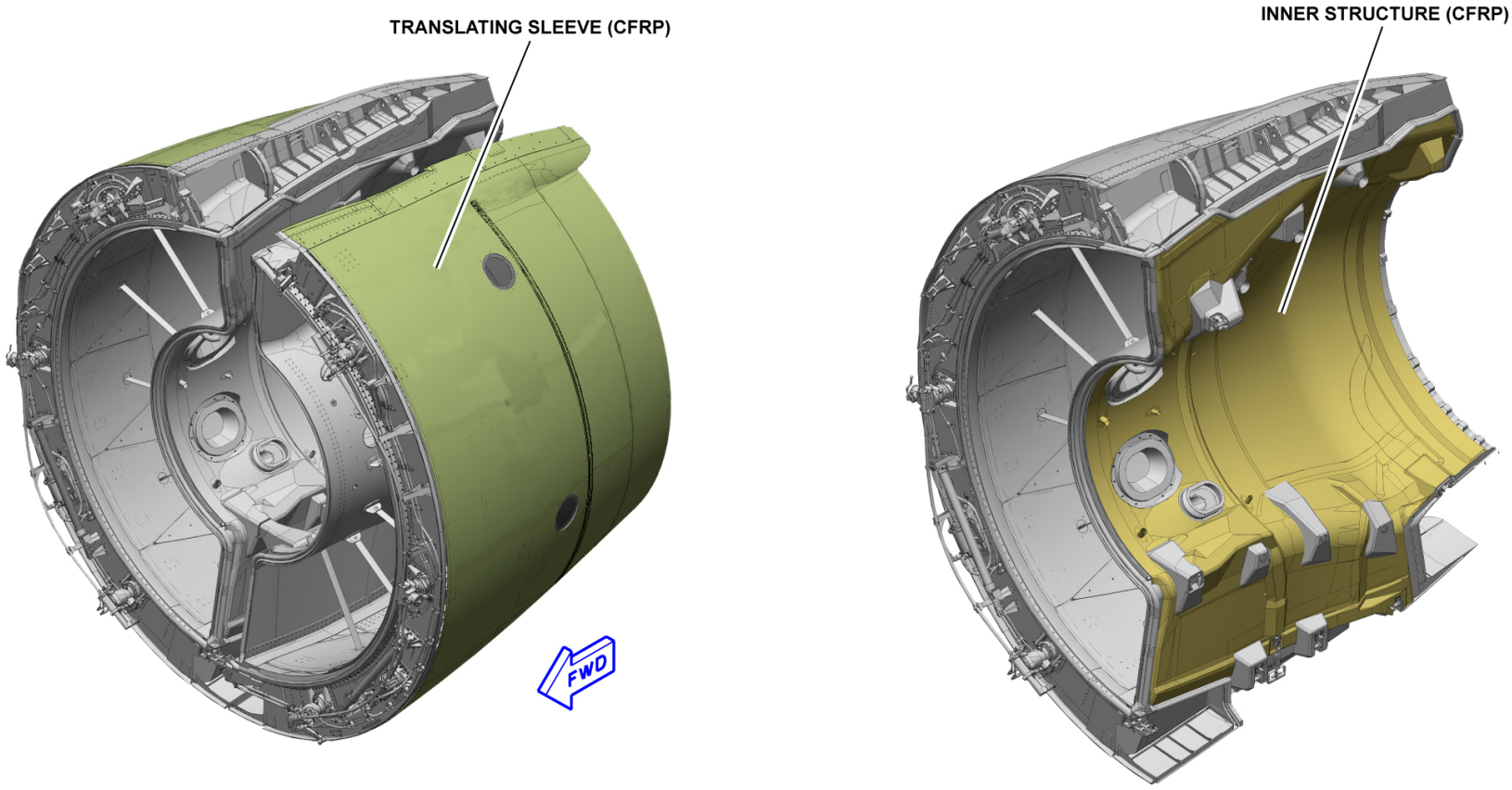
Nacelles (continued)

Thrust Reverser (T/R) Cowls

The T/R cowls are made of monolithic CFRP.

V2414251 - V00T0MM0 - VM51D6PYLON3001

THRUST REVERSER COWLINGS



NACELLES - THRUST REVERSER (T/R) COWLS

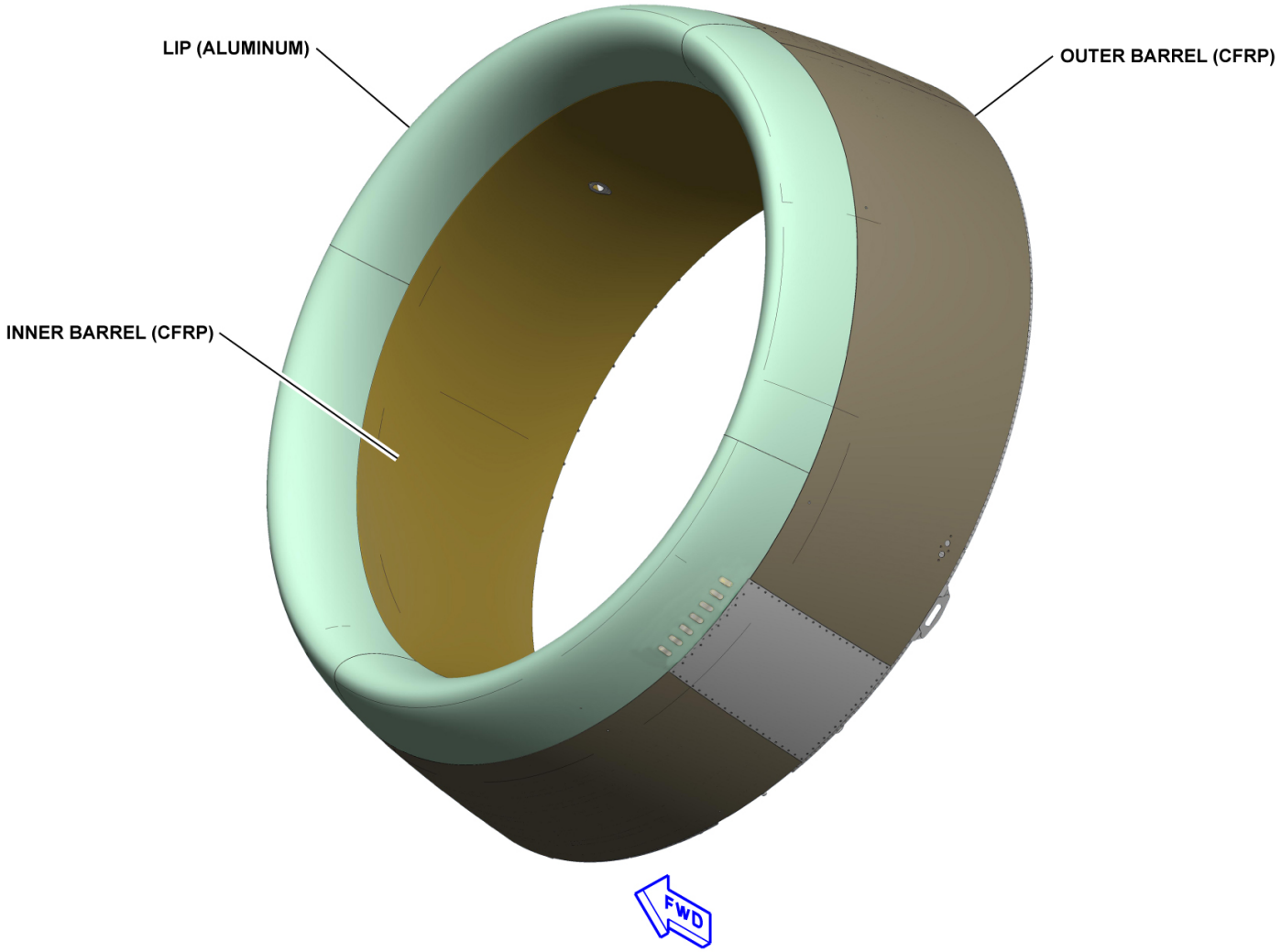
PYLONS AND NACELLES DESCRIPTION (3)

Nacelles (continued)

Air Intake

The air intake is made of monolithic CFRP and the lip is made of aluminum alloy.

V2414251 - V00T0MM0 - VM51D6PYLON3001



NACELLES - AIR INTAKE

COMPOSITE STRUCTURE AWARENESS (3)

Composite Materials

Main Materials

The composite materials used in aircraft industry are a combination of two materials: Fiber and resin (matrix).
- Type of fibers:
- Carbon
- Glass
- Aramid
- Quartz.
- Type of resins:
- Epoxy
- Phenolic
- Thermoplastic.

Different types of fibers are developed for different functions.
The design is decided on the best combination of fiber and resin.

Structure Type

Composites are used in two principal ways:
- Monolithic or laminate structure
- Sandwich structure.

The monolithic structure is made of layers of fibers and resin only.
The sandwich structure is made of a core bonded between two monolithic skins.
Facings and core are bonded together and work as one.

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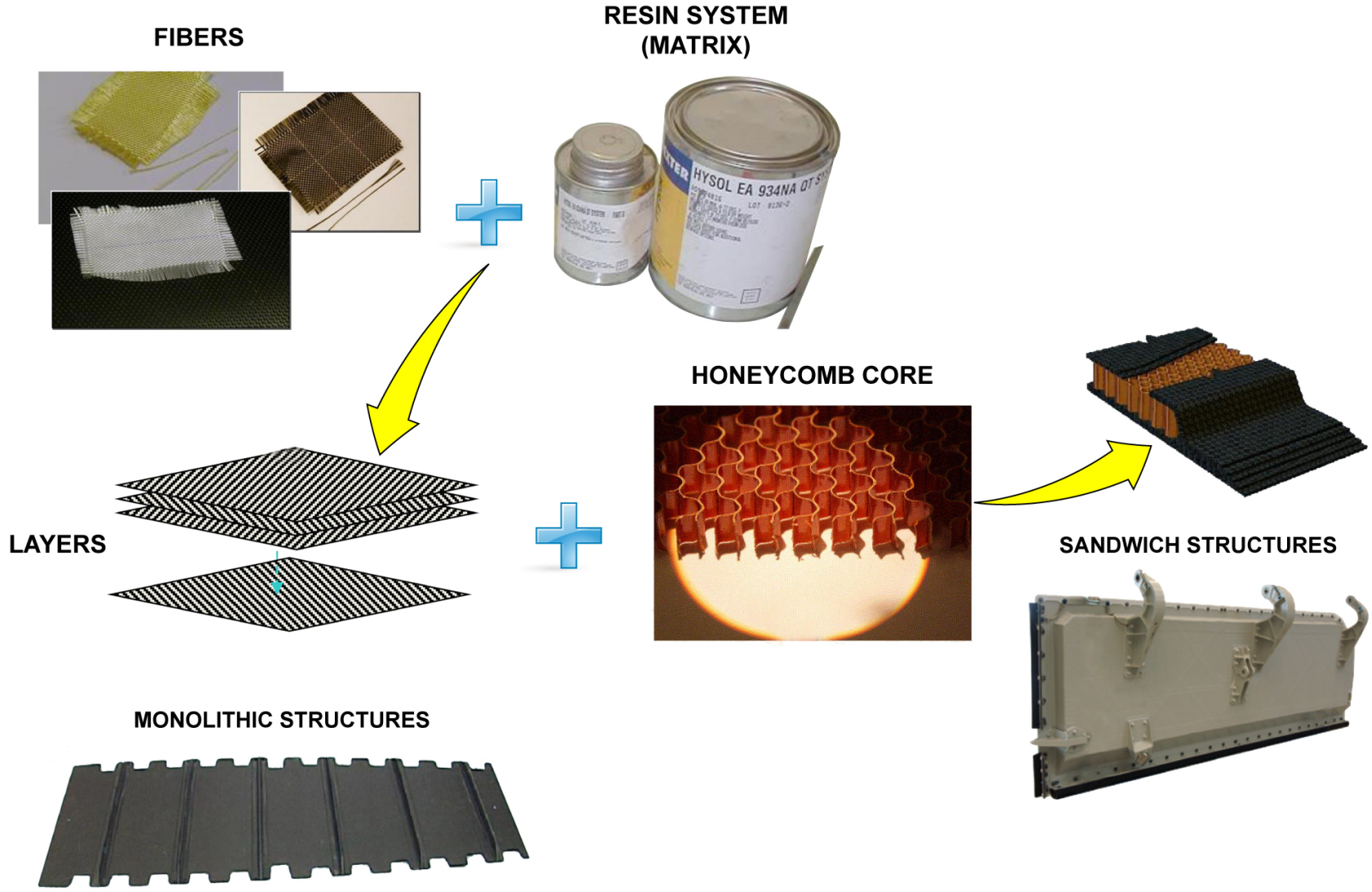

COMPOSITE MATERIALS - MAIN MATERIALS & STRUCTURE TYPE

COMPOSITE STRUCTURE AWARENESS (3)

Composite Materials (continued)

Aircraft Environmental Aggressions

Damage on aircraft can be due to either:
- Environmental aggressions such as rain, hail, high temperature/cold temperature, lightning strike, bird impact or
- Maintenance activities such as ground handling, drop of tools and fluids during maintenance tasks.

On composite structures, impact damage due to the hail, bird impact or maintenance activities can lead to:
- The delamination (between plies)
- Disbonding (between plies and honeycomb core for a sandwich part)
- A combination of delaminations and cracks.

The overheat or too cold temperature in combination with moisture can lead to:
- Resin degradation
- In case of overheated area, discoloration of paint and burnt area
- Micro-cracking due to thermal cycling.

Rain on the leading edge areas can lead to erosion and further to galvanic corrosion. Fluids contamination can degrade the resin and can affect the mechanical properties of the structure.

Lightning strike can lead to:
- Puncture
- Burnt part
- Holes
- Arcing damaging systems and metallic objects.

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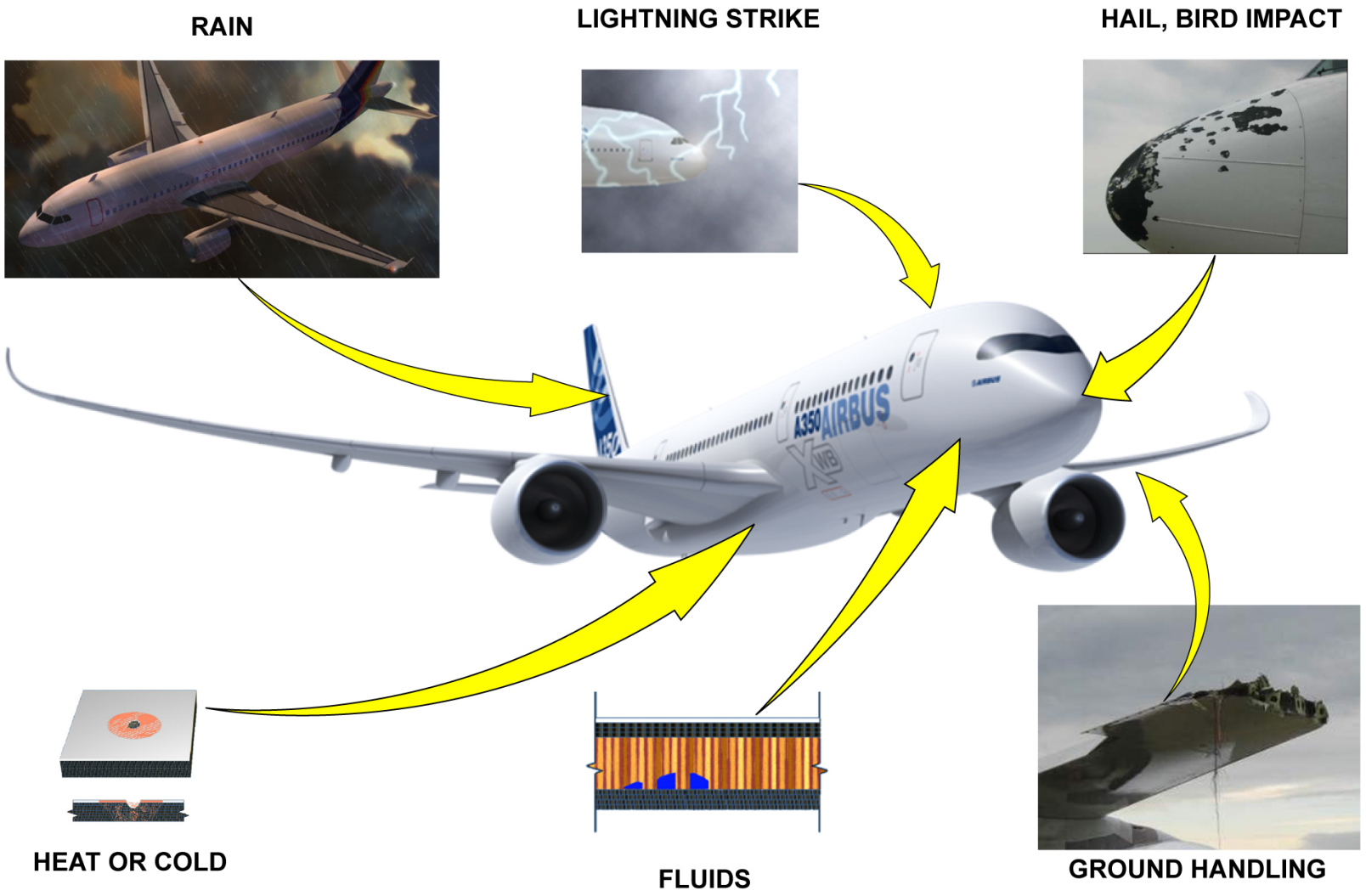
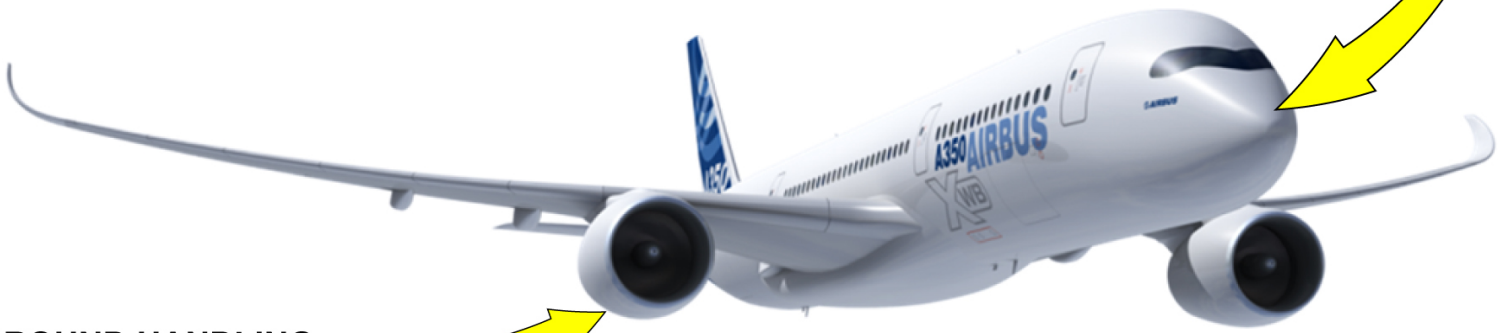


COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

HAIL EFFECT ON A RADOME

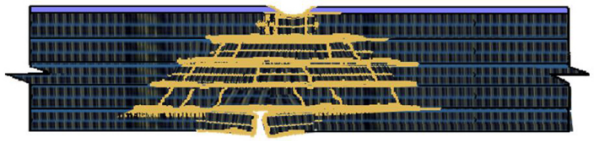
HAIL, BIRD IMPACT

POSSIBLE IMPACT DAMAGE
(IN FLIGHT OR ON GROUND)

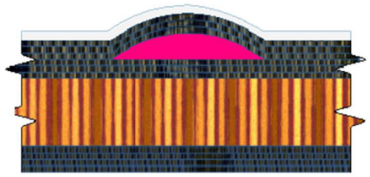


GROUND HANDLING

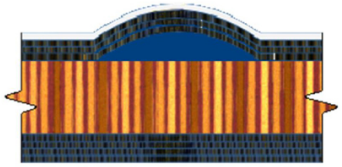
- COLLISION WITH GROUND EQUIPMENT
- IMPACTS DURING SERVICE



FIR-TREE EFFECT:
DELAMINATION AND CRACKS BETWEEN PLIES



DELAMINATION

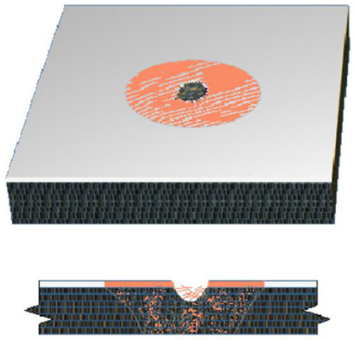


DISBONDING

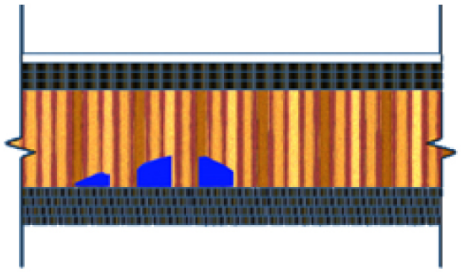
COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

HEAT OR COLD

- SOFTENING OF THE RESIN
- ACCELERATION OF MOISTURE SATURATION
- MICRO-CRACKING BY THERMAL CYCLING



DISCOLORATION OF PAINT AND BURNT RESIN INSIDE THE PART DUE TO OVERHEAT

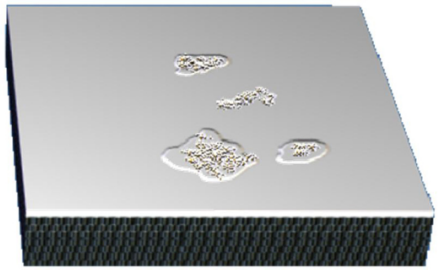


LIQUID INGRESS IN HONEYCOMB CORE

COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

RAIN

- EROSION
- MOISTURE SATURATION
- ELECTROLYTE GALVANIC CORROSION



DEGRADATION OF PAINT DUE TO CHEMICAL POLLUTION

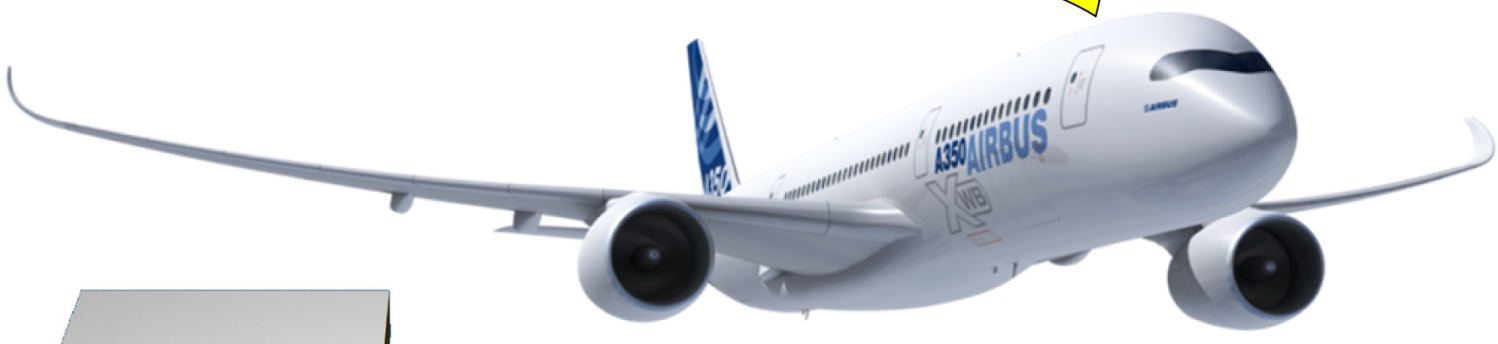
FLUIDS

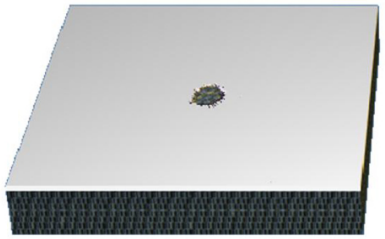
POSSIBLE CHEMICAL DEGRADATION OR SOFTENING OF THE RESIN

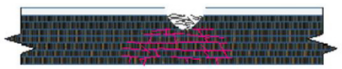
COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

LIGHTNING STRIKE

- IMPORTANT DAMAGE TO UNPROTECTED GFRP OR AFRP
- BURNT PARTS OR HOLES IN CFRP STRUCTURES







GFRP: Glass Fiber Reinforced Plastic
AFRP: Aramid Fiber Reinforced Plastic

COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

COMPOSITE STRUCTURE AWARENESS (3)

Protection of Composite Structure

Lightning Strike Protection

The lightning strike protection zoning is defined according to the probability to get direct or indirect strikes on the aircraft.
For the composite area, a metallic foil is applied on the structure before the application of the paint. The metallic foil makes sure electrical continuity all over the structure. The areal weight of the metallic foil changes according to the zoning (sensitivity to direct or indirect strike attachment).
In metallic area, no additional protection is necessary.

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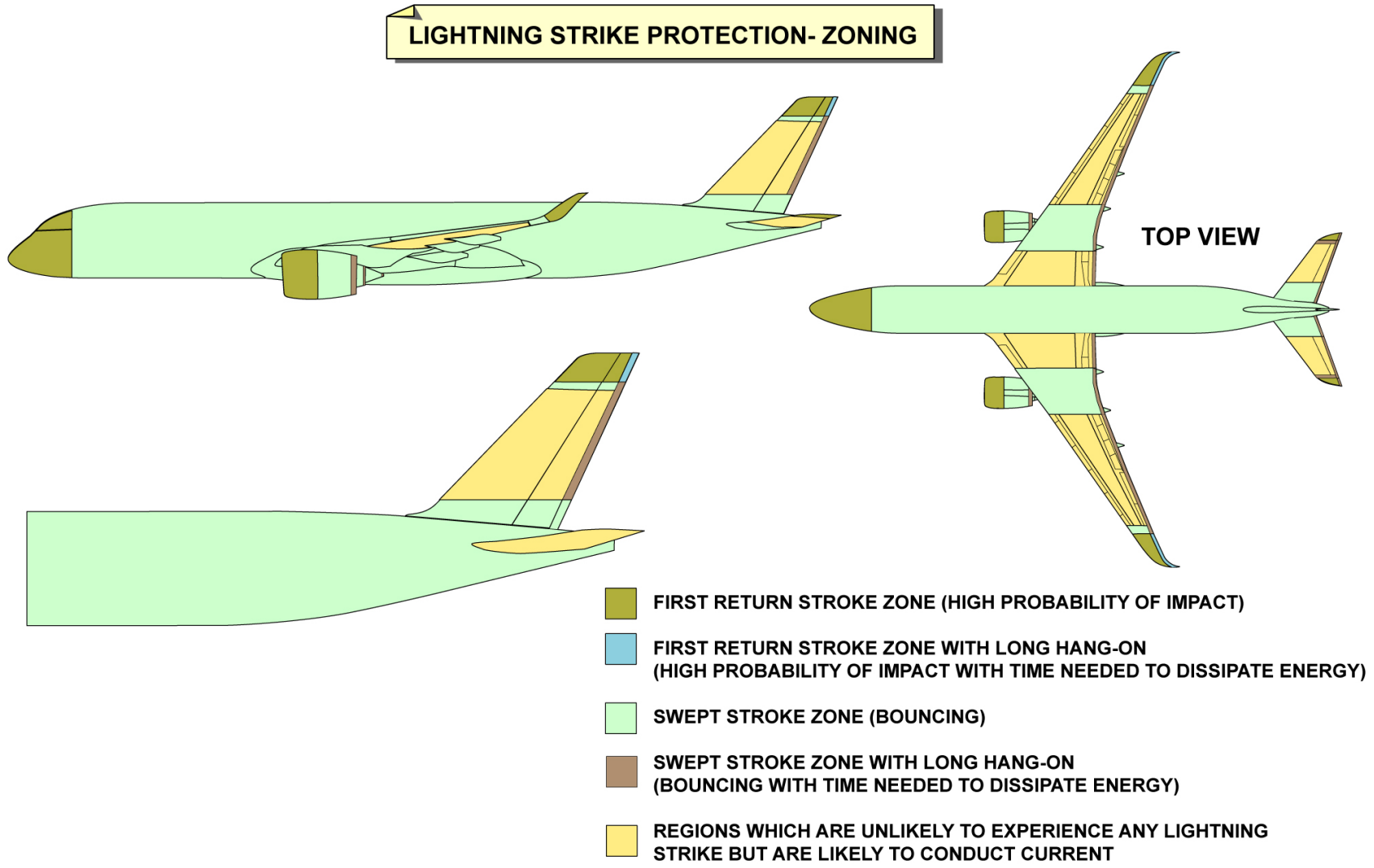
LIGHTNING STRIKE PROTECTION- ZONING
TOP VIEW
FIRST RETURN STROKE ZONE (HIGH PROBABILITY OF IMPACT)
FIRST RETURN STROKE ZONE WITH LONG HANG-ON
(HIGH PROBABILITY OF IMPACT WITH TIME NEEDED TO DISSIPATE ENERGY)
SWEPT STROKE ZONE (BOUNCING)
SWEPT STROKE ZONE WITH LONG HANG-ON
(BOUNCING WITH TIME NEEDED TO DISSIPATE ENERGY)
REGIONS WHICH ARE UNLIKELY TO EXPERIENCE ANY LIGHTNING
STRIKE BUT ARE LIKELY TO CONDUCT CURRENT

PROTECTION OF COMPOSITE STRUCTURE - LIGHTNING STRIKE PROTECTION

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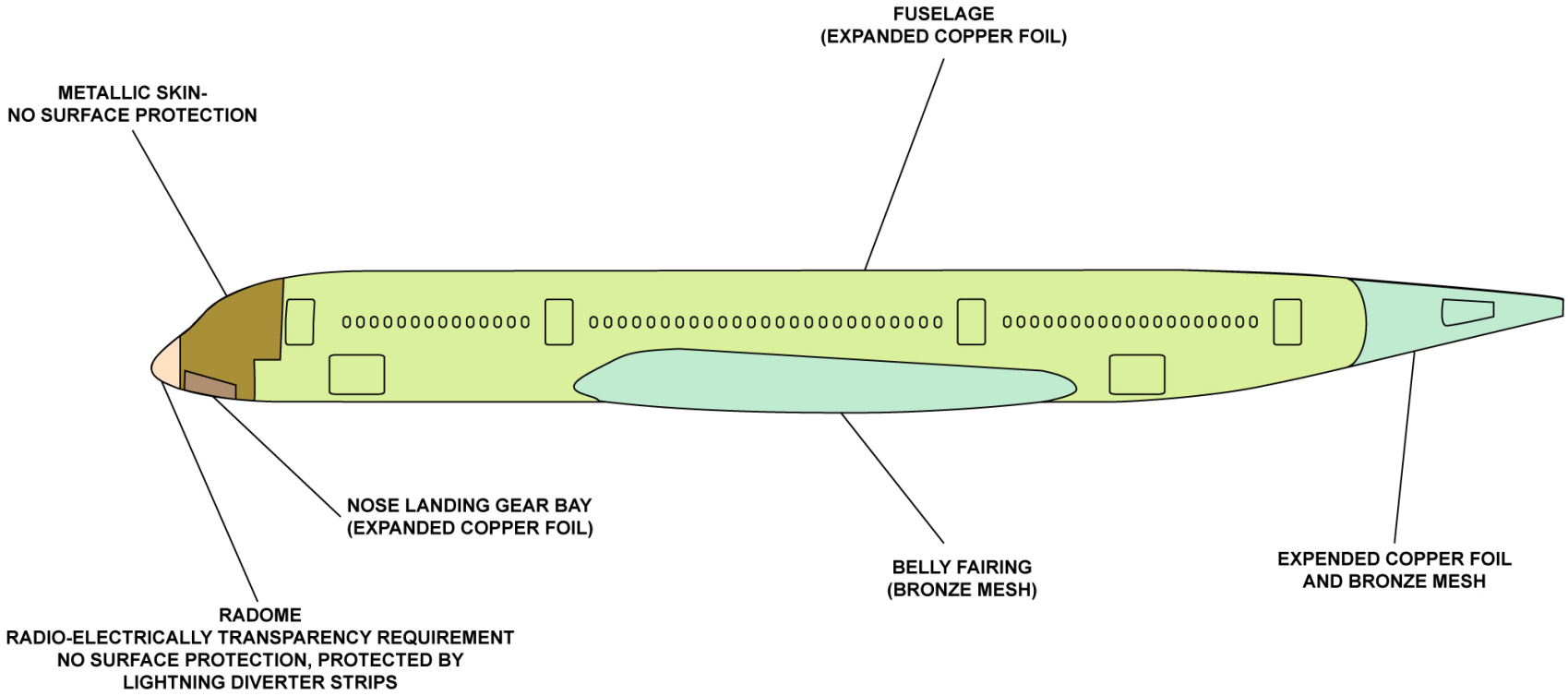
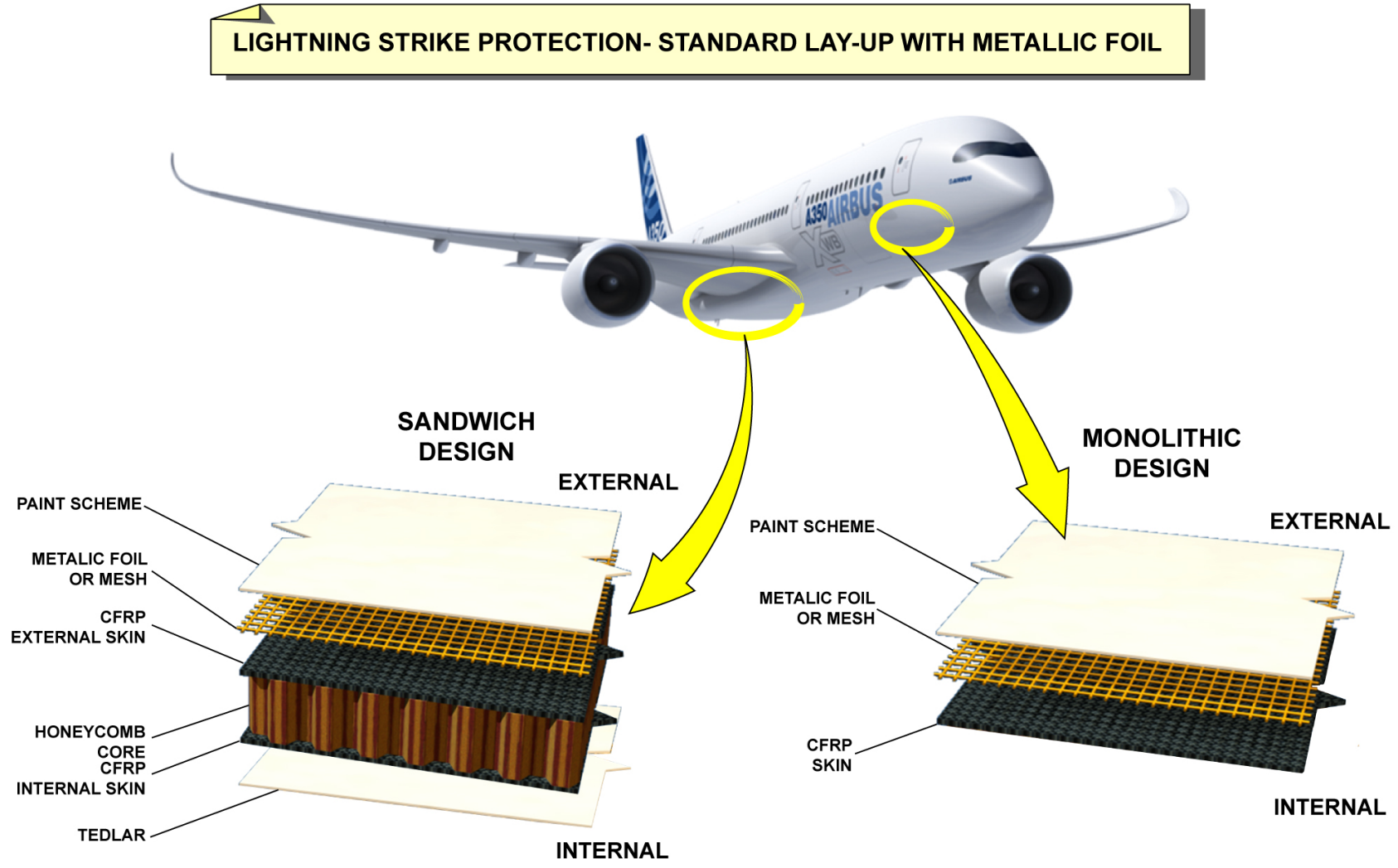
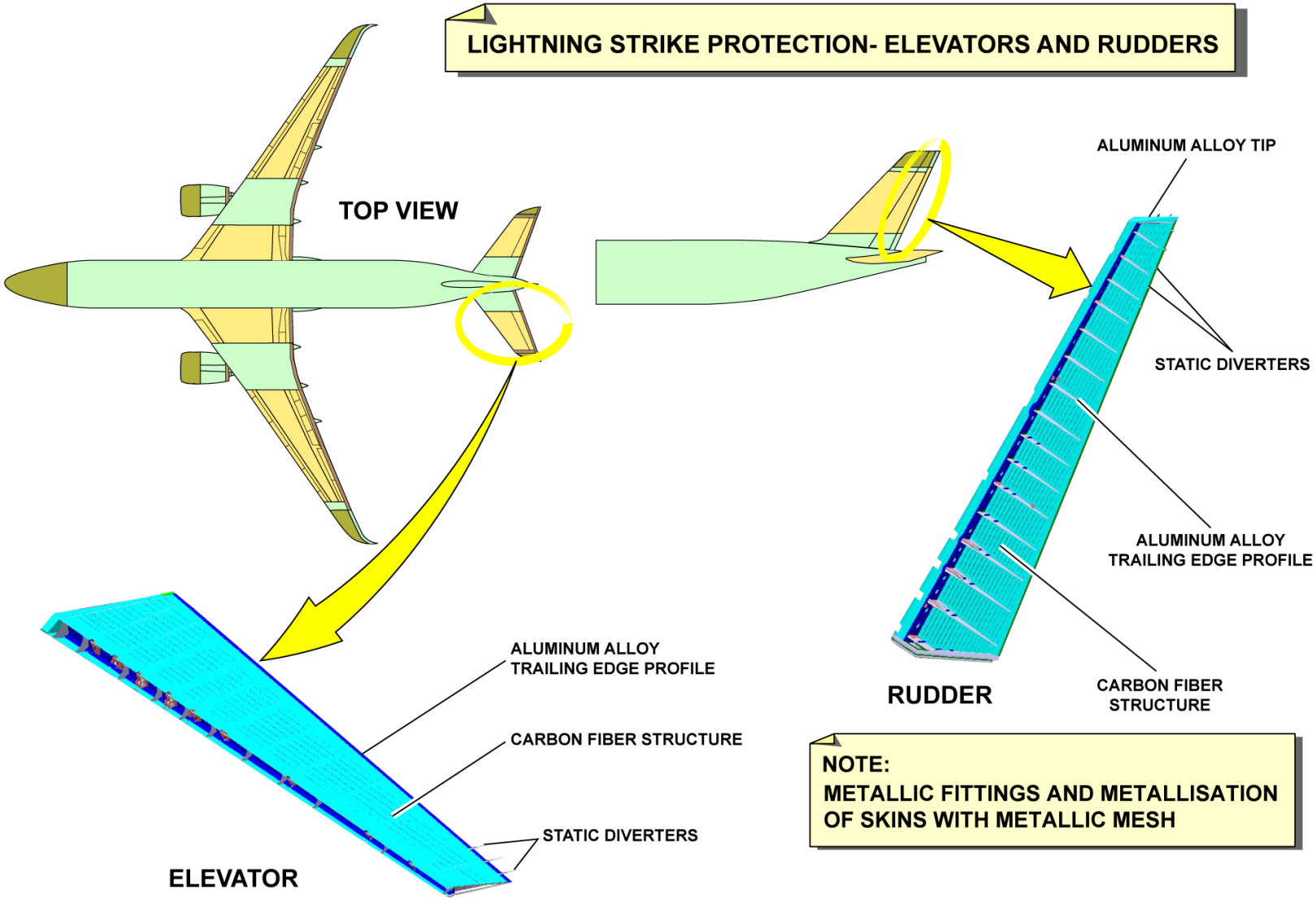
LIGHTNING STRIKE PROTECTION- EXAMPLE FOR FUSELAGE



PROTECTION OF COMPOSITE STRUCTURE - LIGHTNING STRIKE PROTECTION

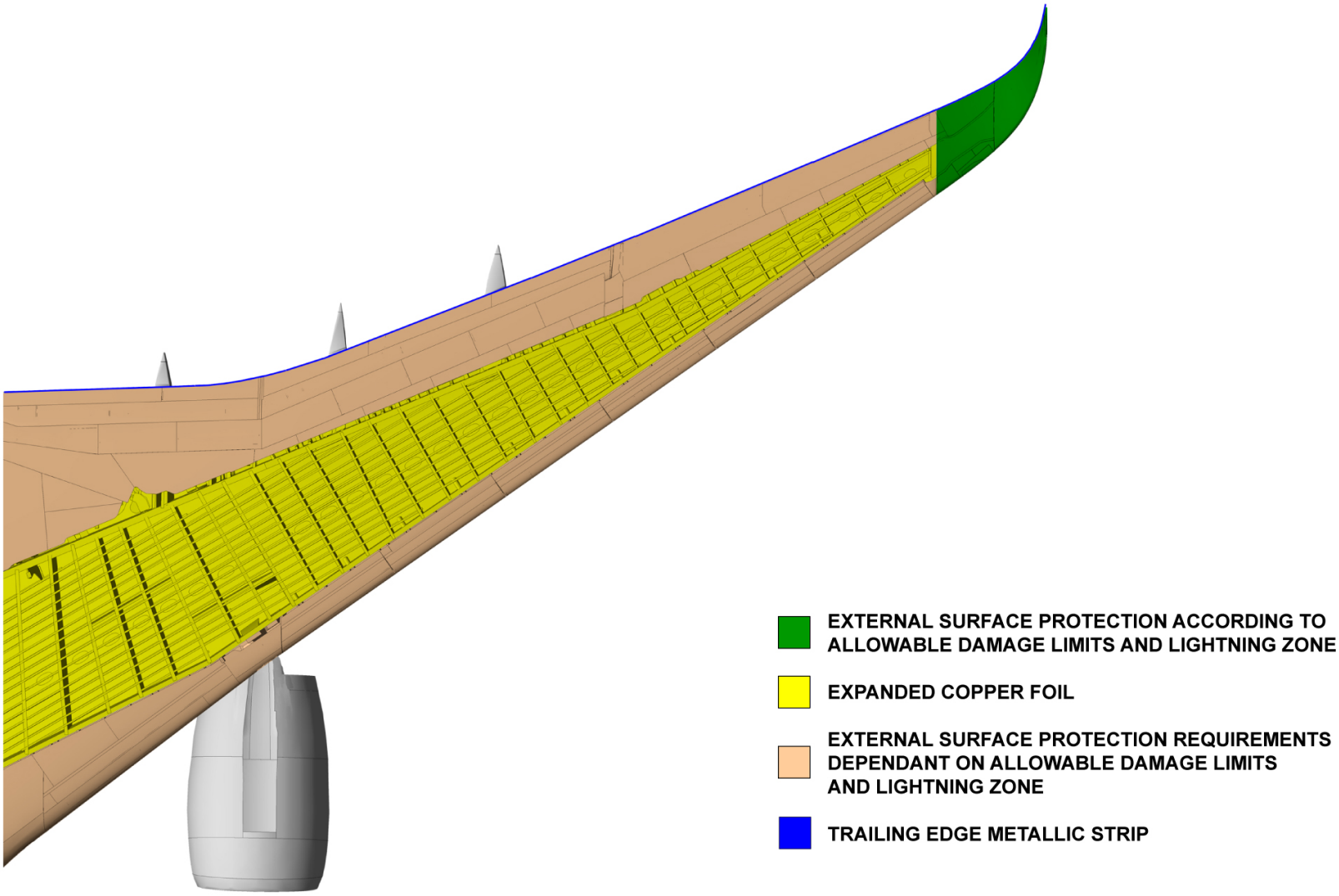


PROTECTION OF COMPOSITE STRUCTURE - LIGHTNING STRIKE PROTECTION



PROTECTION OF COMPOSITE STRUCTURE - LIGHTNING STRIKE PROTECTION

V2414251 - V00T0MM0 - VM51D7AWARE3001


EXTERNAL SURFACE PROTECTION ACCORDING TO ALLOWABLE DAMAGE LIMITS AND LIGHTNING ZONE
EXPANDED COPPER FOIL
EXTERNAL SURFACE PROTECTION REQUIREMENTS DEPENDANT ON ALLOWABLE DAMAGE LIMITS AND LIGHTNING ZONE
TRAILING EDGE METALLIC STRIP

PROTECTION OF COMPOSITE STRUCTURE - LIGHTNING STRIKE PROTECTION

V2414251 - V00T0MM0 - VM51D7AWARE3001

COMPOSITE STRUCTURE AWARENESS (3)

Protection of Composite Structure (continued)

Bird Impact Protection

To protect the structure against bird impact for example:
- In the windshield lower and upper cap: aluminum skin (reinforced with Aluminum 7000)
- On the Trimmable Horizontal Stabilizer (THS), stainless steel plate to cover the leading edge.

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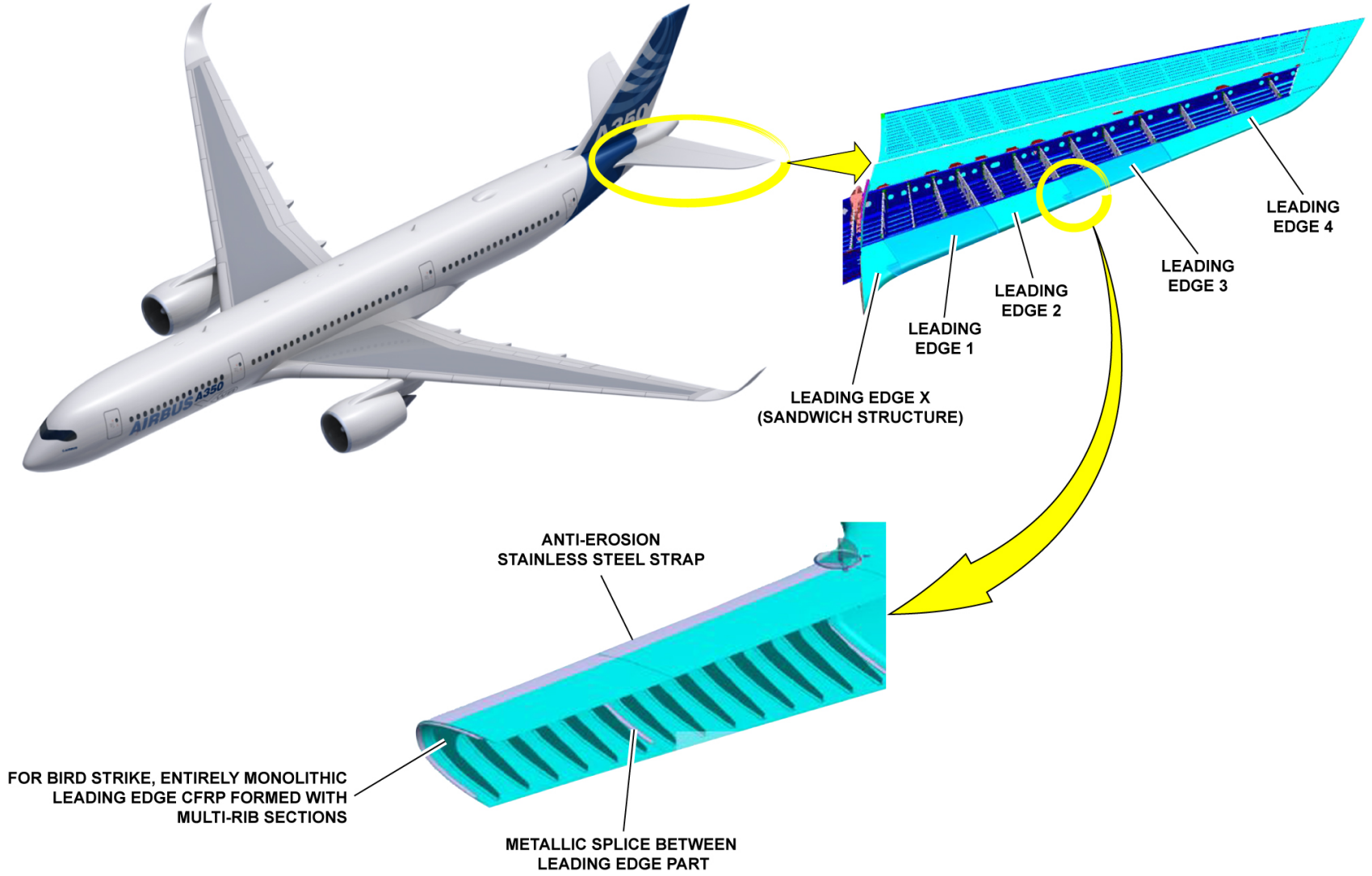
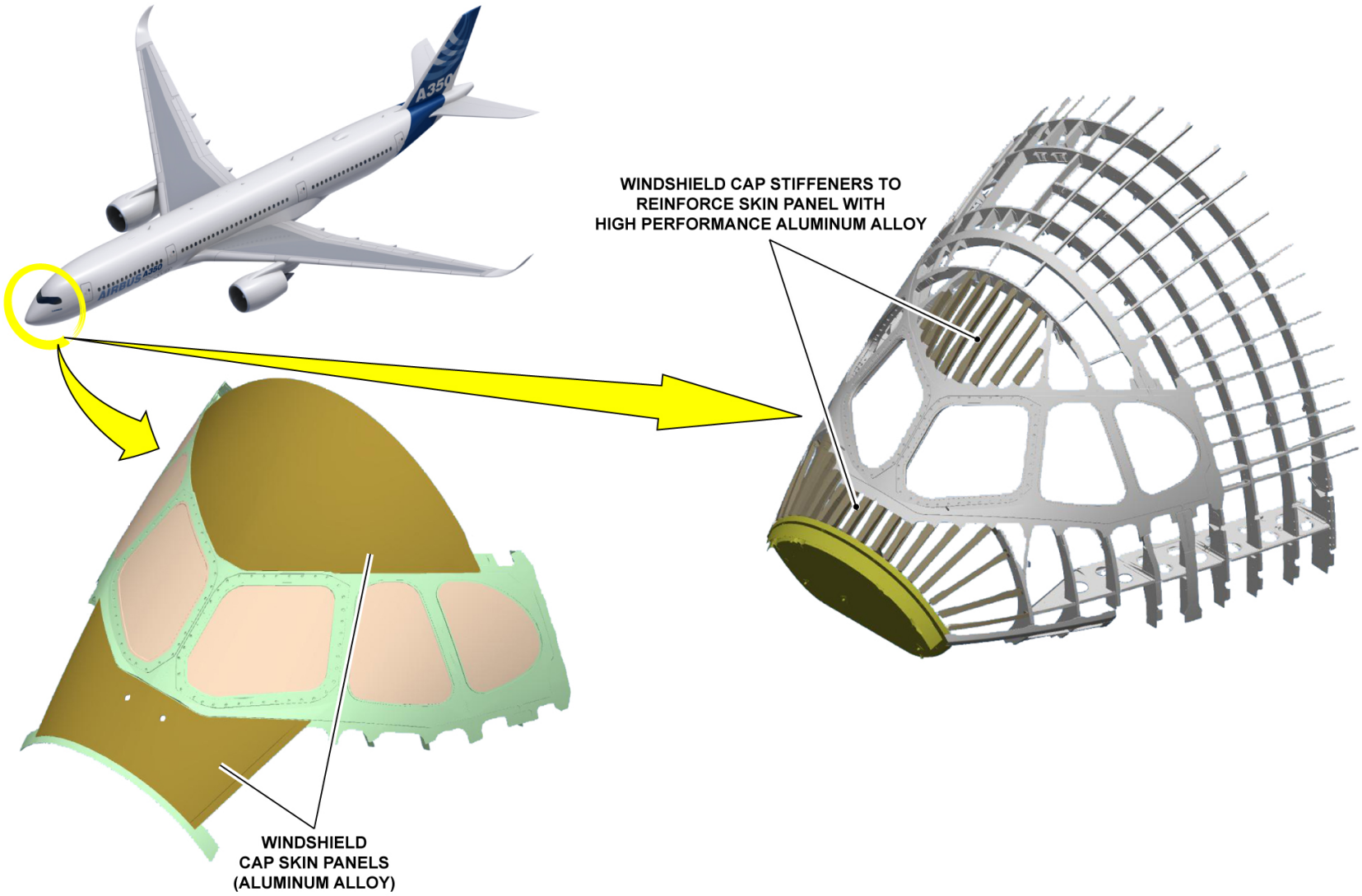

LEADING EDGE 4
LEADING EDGE 3
LEADING EDGE 2
LEADING EDGE 1
LEADING EDGE X (SANDWICH STRUCTURE)
ANTI-EROSION STAINLESS STEEL STRAP
FOR BIRD STRIKE, ENTIRELY MONOLITHIC LEADING EDGE CFRP FORMED WITH MULTI-RIB SECTIONS
METALLIC SPLICE BETWEEN LEADING EDGE PART

PROTECTION OF COMPOSITE STRUCTURE - BIRD IMPACT PROTECTION



PROTECTION OF COMPOSITE STRUCTURE - BIRD IMPACT PROTECTION

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V2414251 - V00T0MM0 - VM51D7AWARE3001

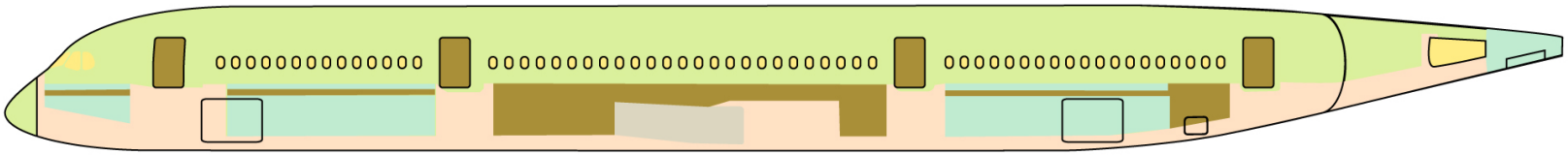
COMPOSITE STRUCTURE AWARENESS (3)

Protection of Composite Structure (continued)

Corrosion Protection - Zoning for Fuselage

Dissimilar assemblies and fastened composite areas are sensitive to corrosion because the combination of Carbon Fiber Reinforced Plastic (CFRP) / aluminum has a high potential difference.
Moreover, the corrosion zoning is done according to the risks of accumulation of water or various fluids accessibility and damage.
Corrosion prevention is provided by compounds and paint application on all the different aircraft sections. Structure drainage (drain holes) is also involved in the corrosion prevention.

V2414251 - V00T0MM0 - VM51D7AWARE3001



CATEGORY A: CONTACT WITH AIR/CONDENSATION (DRY AREAS)

CATEGORY B: CONTACT WITH FUEL

CATEGORY C: AREAS WHICH CAN BE CONTAMINATED BY FLUIDS (OTHER THAN FUEL)

- C1: AREAS IN CONTACT WITH WATER, MOISTURE AND OCCASIONAL EXPOSURE TO OTHER LIQUIDS.
- C2-1: AREAS IN CONTACT WITH WATER, MOISTURE AND FREQUENT EXPOSURE TO OTHER LIQUIDS.
- C2-2: AREAS IN WHICH WATER, MOISTURE AND OTHER LIQUIDS CAN COLLECT AND AREAS OF DIFFICULT ACCESS.

PROTECTION OF COMPOSITE STRUCTURE - CORROSION PROTECTION - ZONING FOR FUSELAGE

V2414251 - V00T0MM0 - VM51D7AWARE3001

COMPOSITE STRUCTURE AWARENESS (3)

Operator's Familiarization and Special Precautions

Damage Assessment

Before the assessment of a damage, do the correct location and identification of the structure:
- Location and geometry of the component
- Materials identification (skin, core, adhesive, etc.)
- Protection (lightning strike, erosion, etc.).

The quality of the inspection and of the repair (if necessary) depends fully on the damage assessment.

Inspection Techniques

The inspection techniques and limitations to perform are described in the Nondestructive Testing Manual (NTM). The selection of an inspection technique depends primarily on:
- The structure type (monolithic or sandwich)
- The geometry and the accessibility of the part
- The suspected damage type.

Special Precautions

During the A/C operations and maintenance procedures, special precautions are necessary to give protection to the composite surfaces/structures.
When the personnel have to do the maintenance work or move on the composite surfaces, make sure that you always install the protection mat on the composite surfaces.

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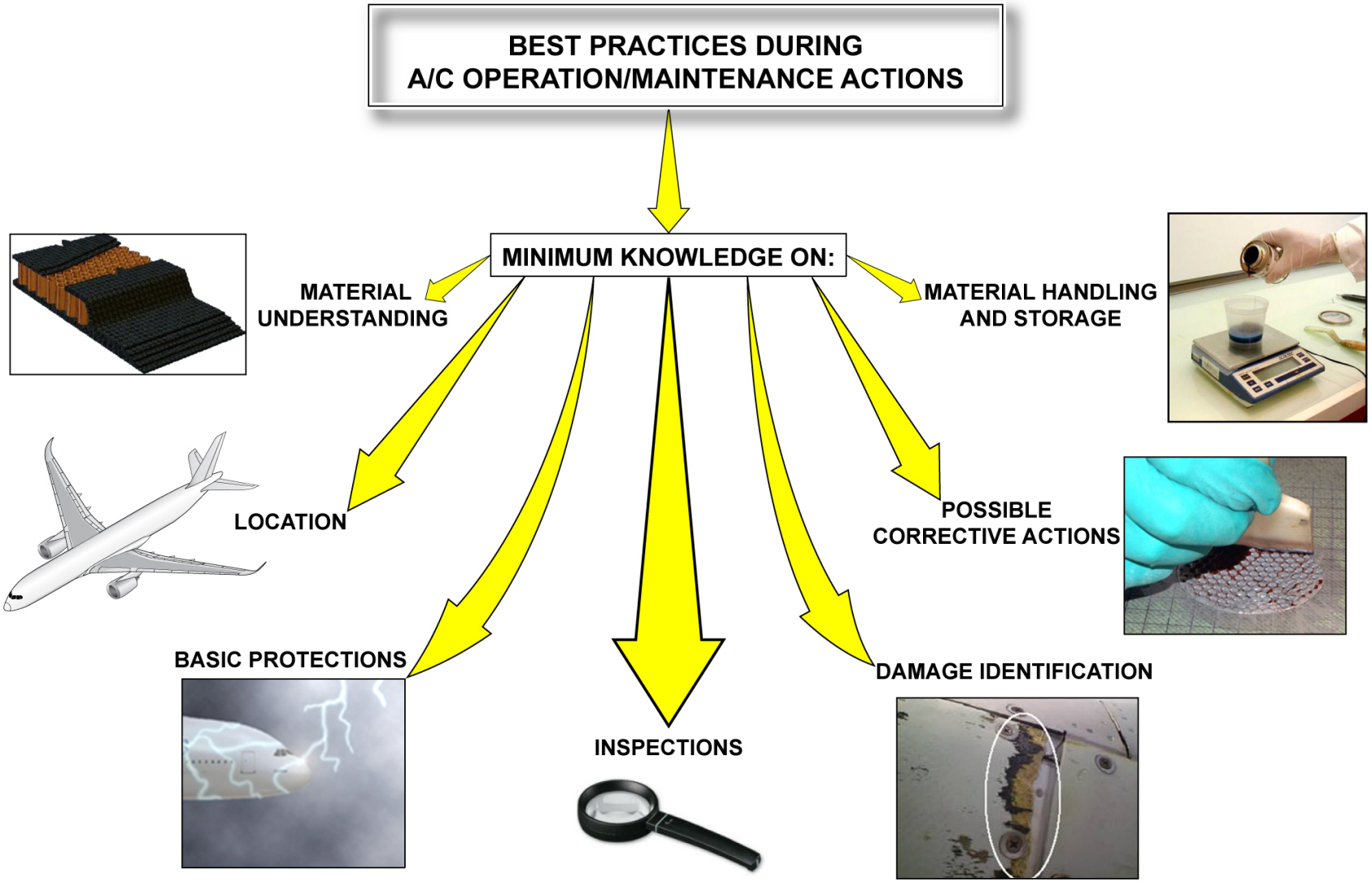
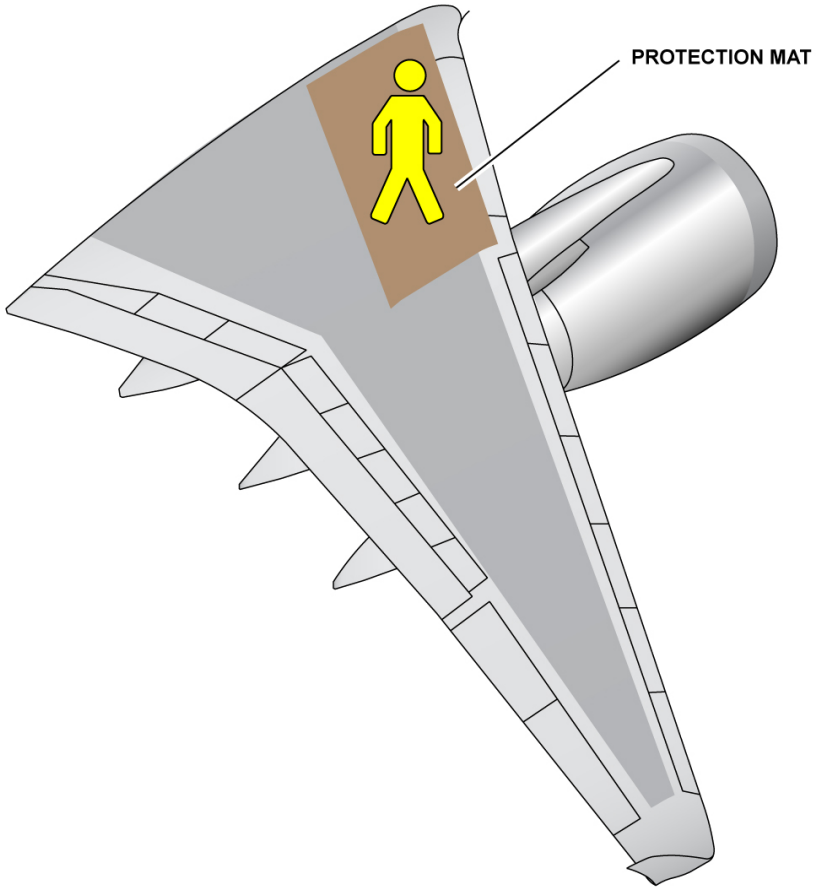


OPERATOR'S FAMILIARIZATION AND SPECIAL PRECAUTIONS - DAMAGE ASSESSMENT ... SPECIAL PRECAUTIONS



CAUTION

**ALWAYS INSTALL PROTECTION ITEMS (e.g.: MAT)
ON SURFACES WHERE THE PERSONNEL HAS TO WORK.**

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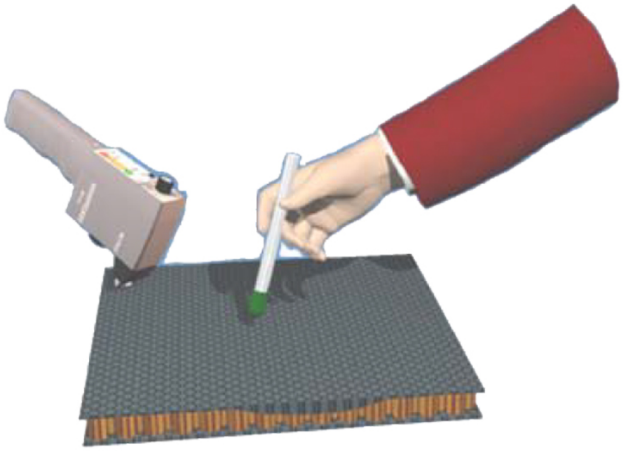
DELAMINATION AND DISBOND DETECTION

FOR SANDWICH STRUCTURES



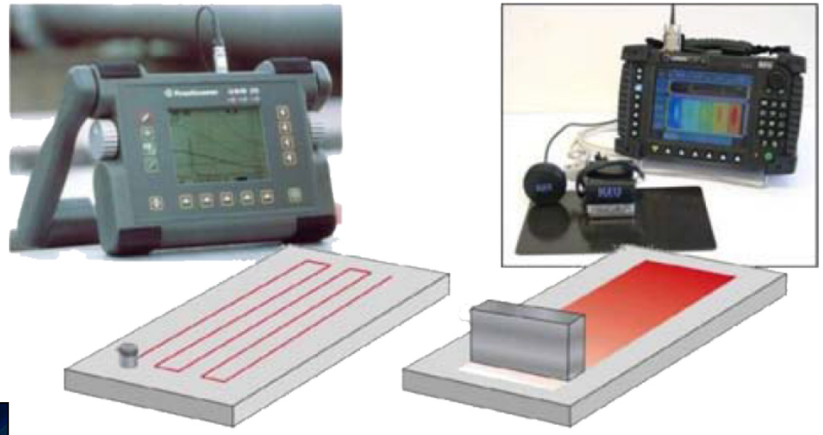
MANUAL TAP TEST
OR AUTOMATIC TAP TEST

LINE TOOL

FOR MONOLITHIC STRUCTURES

SINGLE TRANSDUCER (TRADITIONAL)

ARRAY TRANSDUCER



ULTRASONIC INSPECTION

CAUTION

REFER TO THE NON-DESTRUCTIVE TESTING MANUAL FOR INSPECTION PROCEDURE AND LIMITATIONS

OPERATOR'S FAMILIARIZATION AND SPECIAL PRECAUTIONS - DAMAGE ASSESSMENT ... SPECIAL PRECAUTIONS

ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN) AWARENESS (3)

Electrical Structure Network (ESN) and Metallic Bonding Network (MBN)

Carbon Fiber Reinforced Plastic (CFRP) material has low electrical conductivity compared to metal.
To achieve the same electrical and environmental performance of aircraft metallic structures, two different technical solutions have been implemented on the A350 XWB depending on the area and the expected function.
In the pressurized fuselage a highly distributed conductive network, known as the Electrical Structure Network (ESN) is achieved thanks to both existing metallic structure parts and to specific ESN parts.
This network offers the electrical and environmental conditions required for the correct functioning of aircraft systems. Due to the discrete characteristics and electrical properties of carbon, compared to a metallic fuselage, particular attention should be given to maintain the ESN system's performance during the entire life of the aircraft.
Elsewhere a Metallic Bonding Network (MBN) has already been used on other aircraft. It consists of a network of metallic parts, electrically bonded together and used for a failure current return path, equipment bonding, as well as lightning and electro-static discharge protection. This network is neither used as a functional current path (grounding) nor to distribute the voltage reference to the equipment located in the area. These functions are ensured thanks to dedicated cables routed in the harnesses. Each MBN sub-network (wings, belly fairing, etc.) is connected to the ESN.
The MBN (in unpressurized areas) gives:
- Lightning strikes protection
- Electrostatic protection
- Electrical current path (bonding)
- Connection to the earth when the A/C is on the ground.

The ESN (in the pressurized fuselage) gives:
- Lightning strikes protection
- Electrostatic protection
- Electrical current path (bonding)
- Connection to the earth when the A/C is on the ground
- Electrical current return signal (grounding)
- Provision of common Point of Voltage Reference (PVR) for all electrical components.

The ESN and MBN are mechanically connected together.

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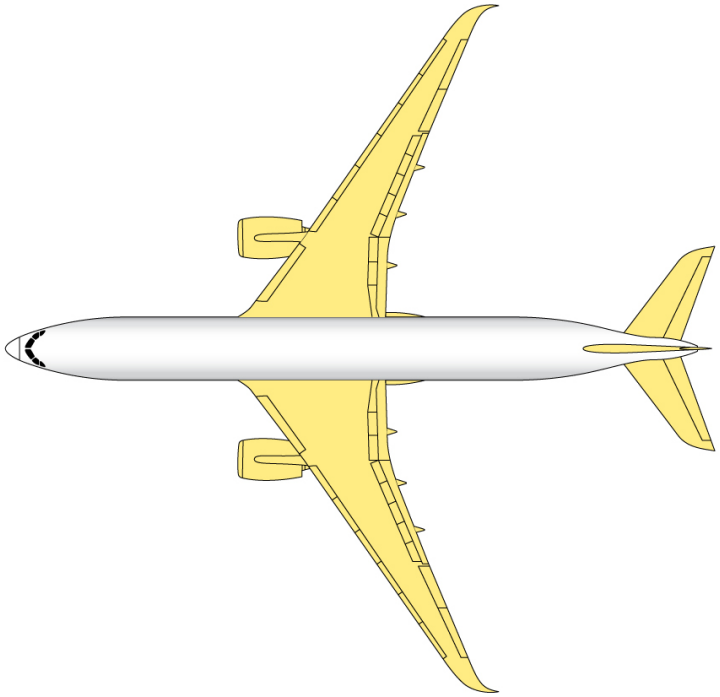
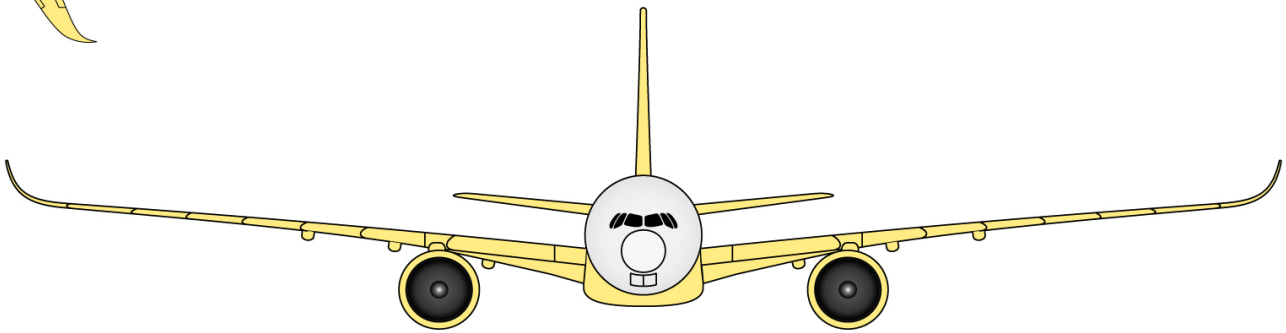


ESN	MBN	FUNCTION
X		ENSURES THE FUNCTIONAL CURRENT RETURN (GROUNDING)
X	X	PROVIDE A CURRENT PATH FOR FAULT CURRENT AND ELECTROSTATIC CURRENT (BONDING)
X		DISTRIBUTES A COMMON VOLTAGE REFERENCE
X	X	ENSURE LIGHTNING STRIKE PROTECTION
X	X	PROVIDE A CONNECTION TO THE EARTH WHEN THE A/C IS ON GROUND
X	X	PREVENT THE ACCUMULATION AND EVACUATE THE STATIC ELECTRICITY



METALLIC BONDING NETWORK AREA

ELECTRICAL STRUCTURE NETWORK AREA

ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN)

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ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN) AWARENESS (3)

Metallic Bonding Network (MBN) Purpose

The MBN is a network of metallic parts electrically bonded together. It has metallic parts of the primary structure and connecting parts (like metallic strips and bonding jumpers). The MBN runs through the wings, the horizontal and vertical tail plane and is not isolated from the fuselage CFRP structure. It is used for electrical bonding purposes, such as failure current return, lightning protection and electrostatic discharge. All the bonded equipment must have the same electrical potential.

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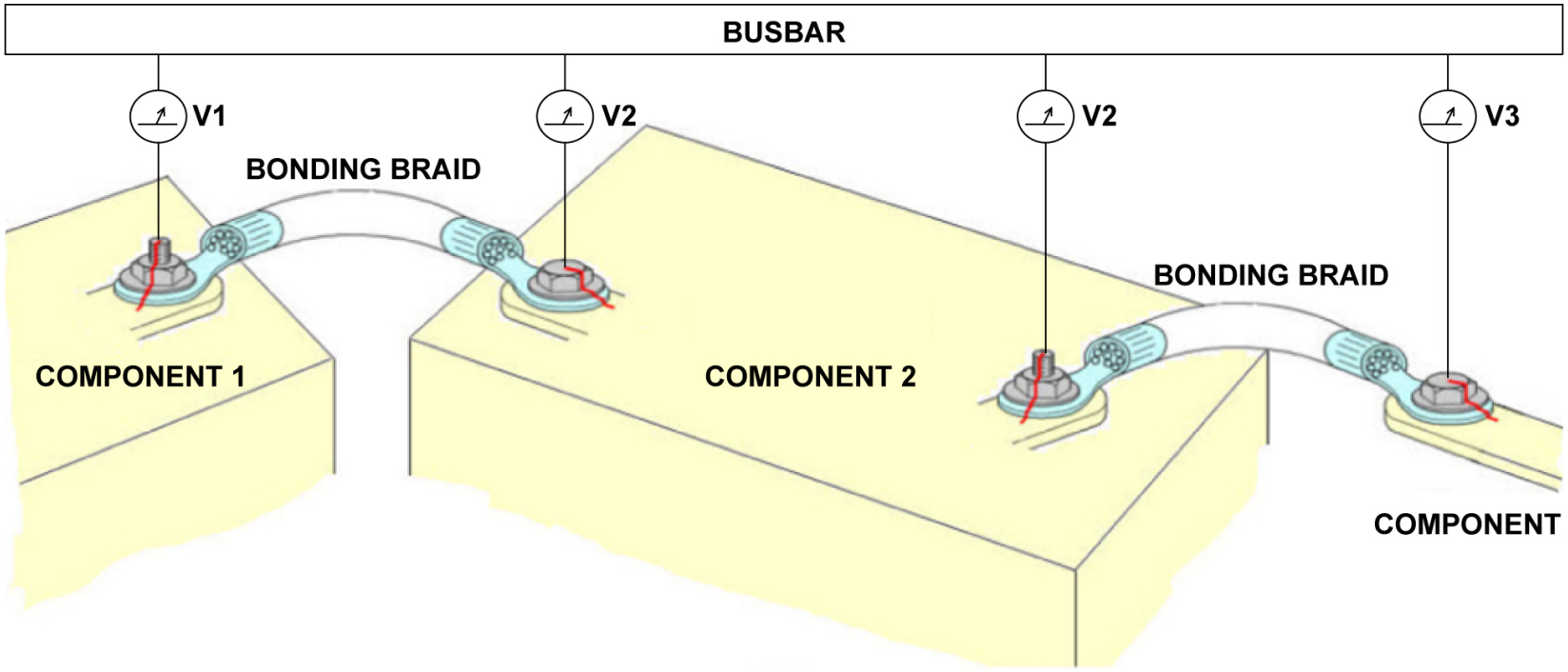
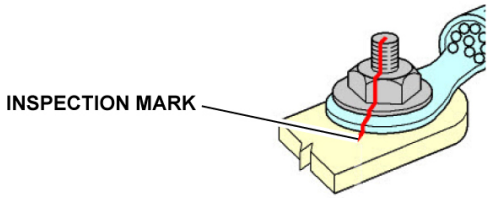


V1 ELECTRICAL POTENTIAL COMPONENT 1 = V2 ELECTRICAL POTENTIAL COMPONENT 2 = V3 ELECTRICAL POTENTIAL COMPONENT 3



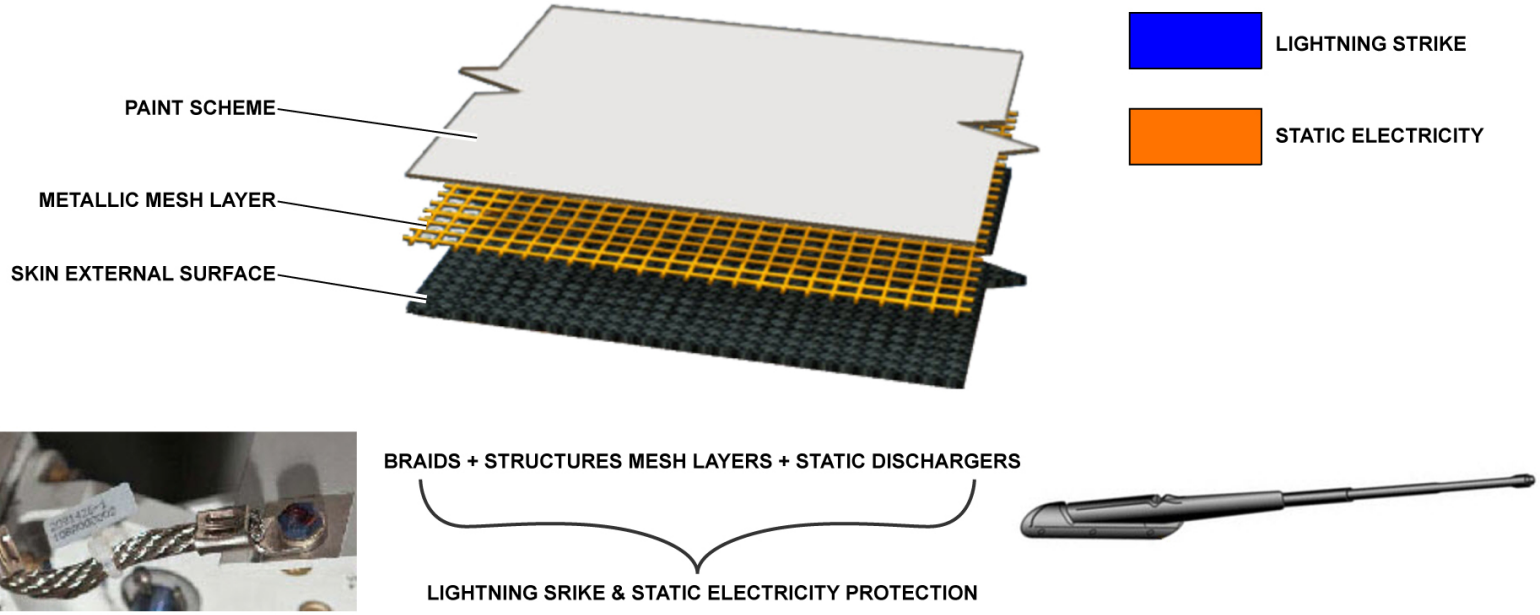
METALLIC BONDING NETWORK (MBN) PURPOSE

ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN) AWARENESS (3)

Lightning Strikes and Static Electricity Protection

The MBN and ESN bonded together are used for lightning strikes and static electricity protection.

NOTE: Protection depends on structure, skin, bonding braids, static dischargers condition.



LIGHTNING STRIKES AND STATIC ELECTRICITY PROTECTION

ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN) AWARENESS (3)

ESN Purpose

A standard aircraft fuselage has electrical functions such as grounding, bonding, voltage reference and protection from electromagnetic hazards. This function is primarily done by the metallic structural frames, stringers and skin panels.
All the AC or DC electrical source supplies power through busbars on which the electrical equipment are connected. The functional current return is supplied by conductive metallic structural components connected and attached to the A/C structure.
Since CFRP is low conductive, a metallic network is installed inside the A/C. This is known as the ESN.
The ESN is a metallic structure used as a common current return for all circuits in the pressurized fuselage and a voltage reference for discrete signals. Also, it is used for bonding and as connection to the ground.
All the ESN parts also provide the lightning strike protection.
The PVR is the power-supply voltage reference. All the AC and DC source neutral are connected to the PVR.
All functional and power current will go back to the PVR through the ESN or dedicated wire.
The PVR is installed in the avionic bay and is made of metallic elements.

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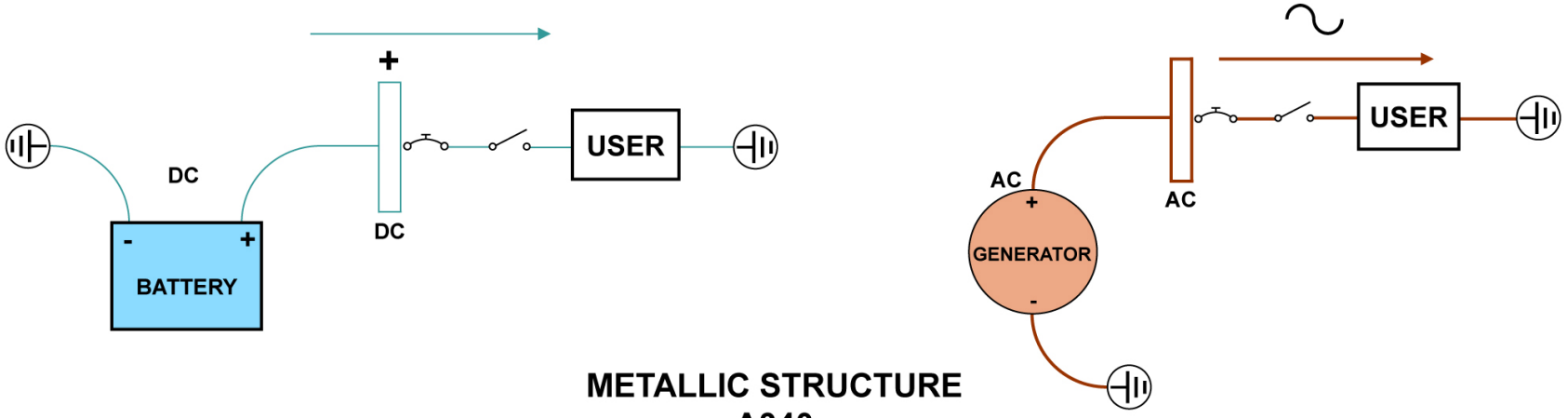
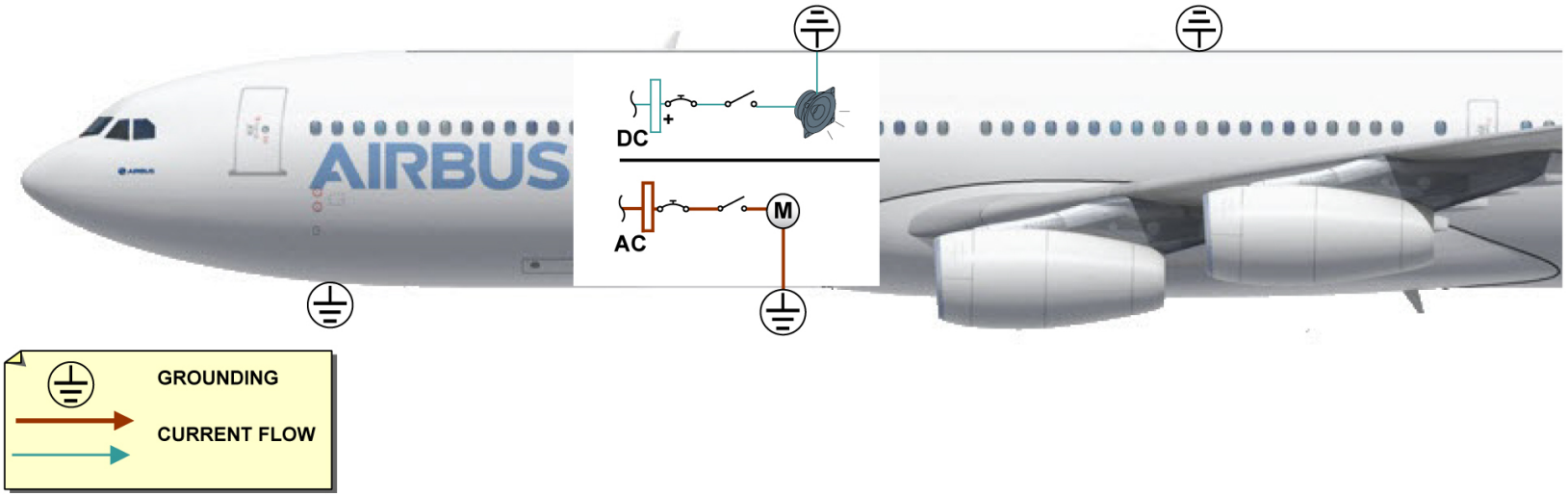
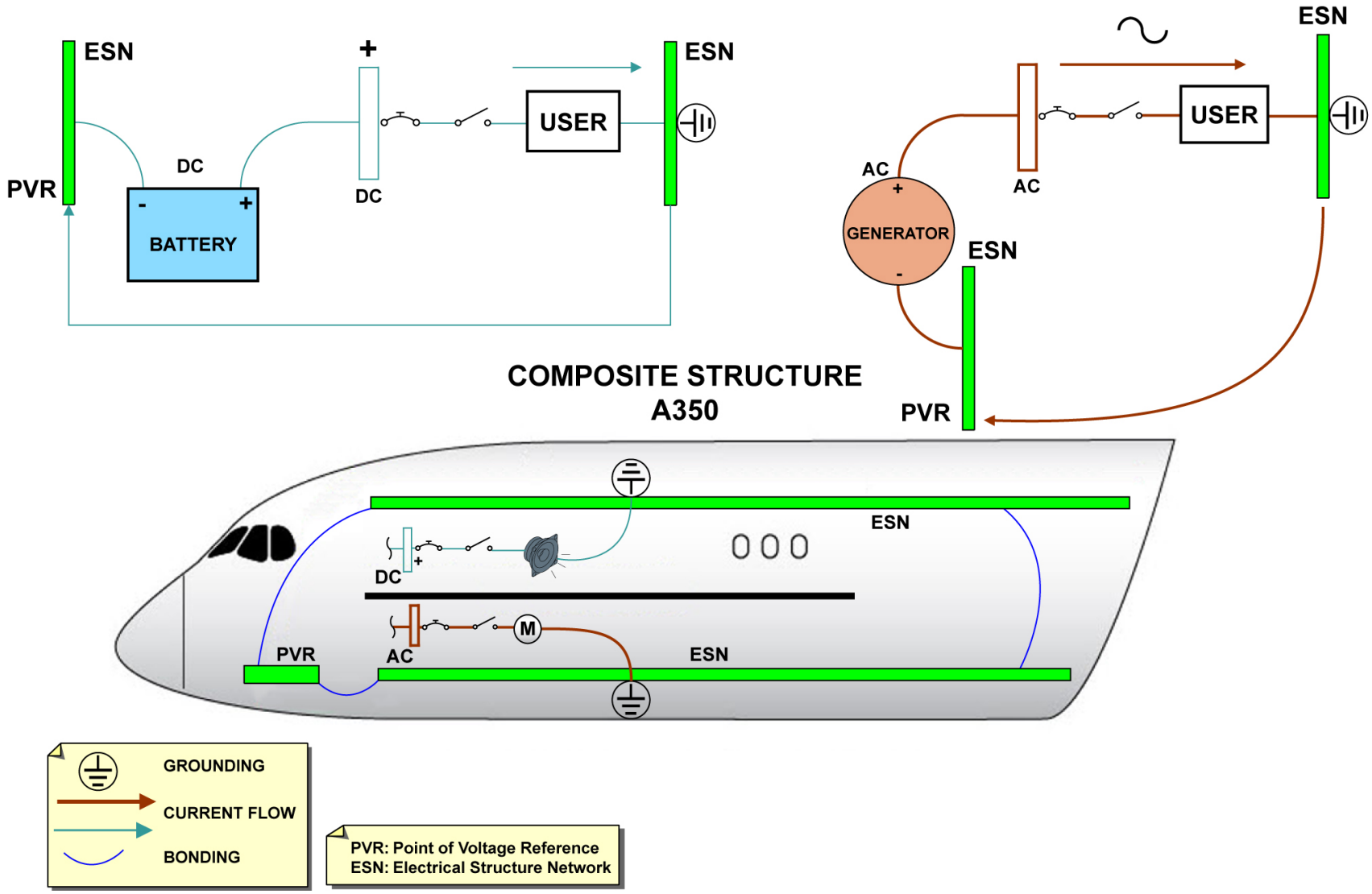


METALLIC STRUCTURE
A340



ESN PURPOSE


ESN
+
ESN
USER
PVR
DC
DC
-
+
BATTERY
ESN
USER
AC
AC
+
GENERATOR
-
ESN
COMPOSITE STRUCTURE
A350
PVR
ESN
DC
+
M
PVR
AC
ESN
GROUNDING
CURRENT FLOW
BONDING
PVR: Point of Voltage Reference
ESN: Electrical Structure Network

ESN PURPOSE

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V2414251 - V00T0MM0 - VM51D8ESNDO3001

ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN) AWARENESS (3)

ESN Elements

The ESN is an electrically conductive network. A part of the ESN is the metallic primary and secondary structure installed in the pressurized fuselage. ESN is linked with the metallic structures and composed of existing structural metallic components such as frames, cabin floor crossbeams, seat tracks, support struts, cargo floor crossbeams, cargo roller tracks, cargo struts.
There are also additional components such as ESN cables, raceways (wire bundles routing), flexible junctions.
The MBN is a network of metallic parts, electrically bonded together. It consists of metallic parts of the primary structure as well as connecting parts, like metallic strips and bonding braids. The MBN runs through the wings, the horizontal and vertical tail plane and is not isolated from the fuselage CFRP structure. It is used for electrical bonding purposes, such as failure current return, lightning protection and electrostatic discharge. It is not used as current return path for power supplies or signals.
For information, ATA 24, 50, 52, 53, 54, 55, 57 and 92 are involved in the ESN / MBN.

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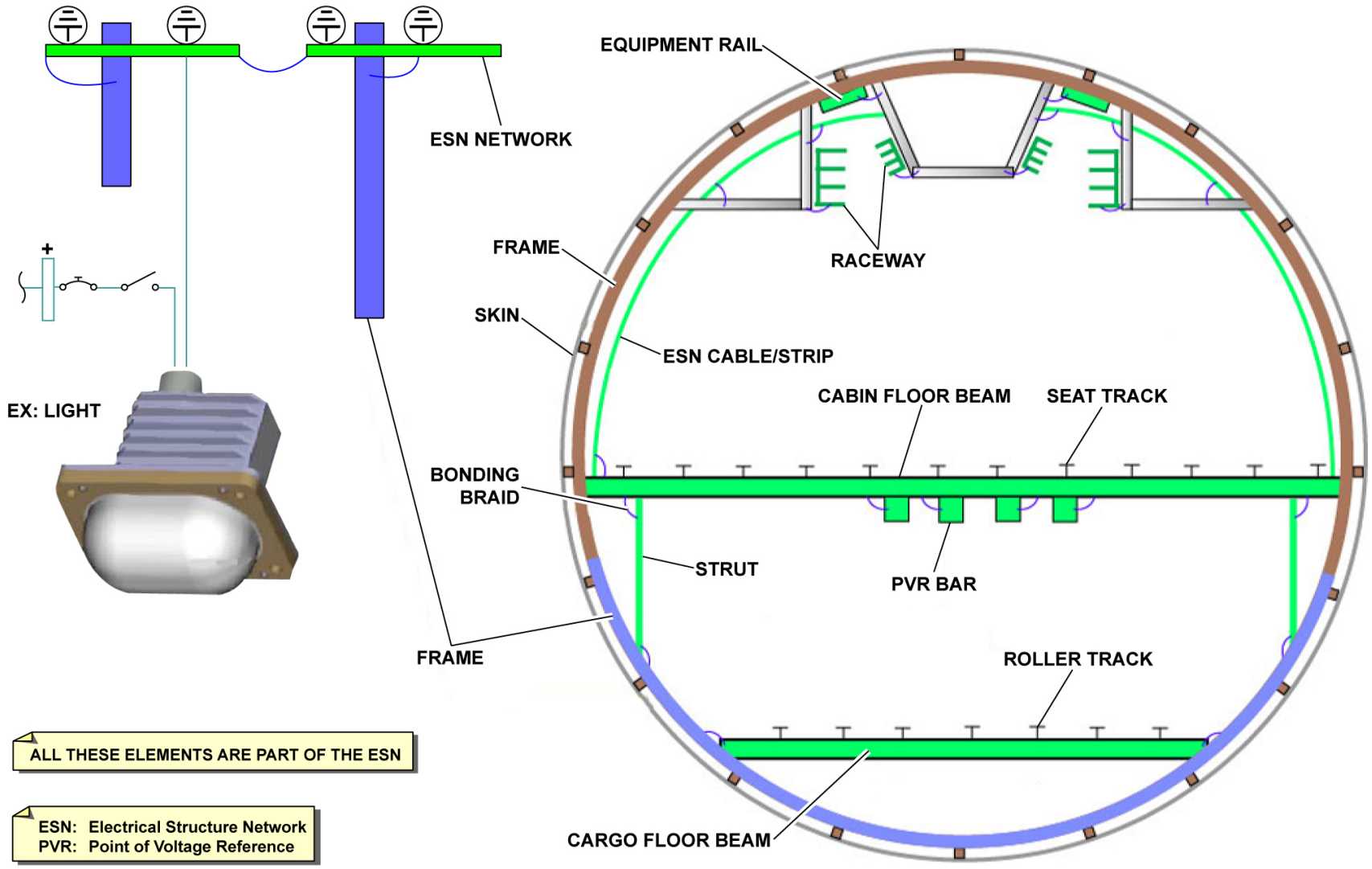

ESN ELEMENTS

ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN) AWARENESS (3)

ESN Precautions

The use of ESN is necessary for the systems operation. Since the grounding is provided by the ESN to the PVR, any open/bad link between several components and the ESN could cause system malfunction.
Also, caution is necessary if there is loose wire connection, because it can cause electric shocks.

NOTE: The ESN function depends on the ESN components and structure condition.

Make sure that the contact surfaces are clean, not contaminated and not painted.
Any non-approved, dirty, damaged hardware (bolts, washers, nuts...) may cause system malfunction due to the possible poor return path caused by such hardware.
Bad torque values applied on fasteners may cause system malfunction and/or arcing between components and therefore potential damage.
Damaged ESN junctions or elements may cause system malfunction due to the possible poor return path caused by such hardware.
Replacement or repair should be done as soon as possible.
In case of damage, maintenance procedures (former AMM) 24-77-00 provide guidelines for dispatch. The general rule is as follows:
If an ESN element is damaged, the other ESN elements in adjacent area (dimensions given by MP) must be inspected. If no other damage is reported, repair of the damaged element can be postponed (repair interval given by MP).

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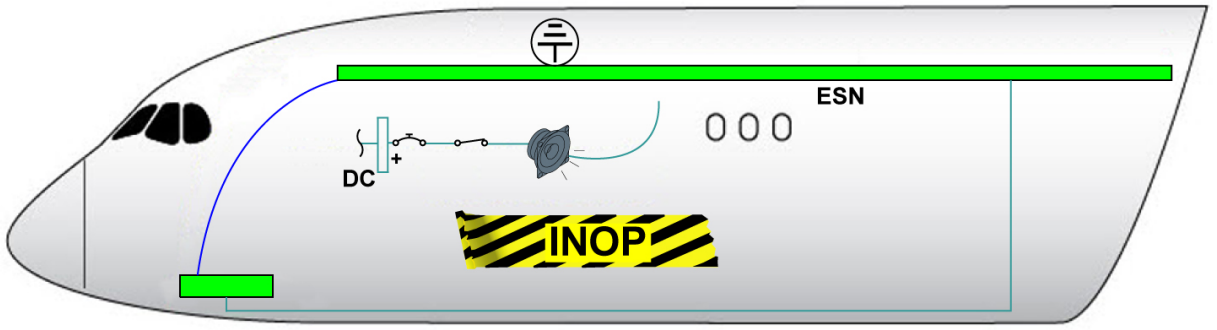
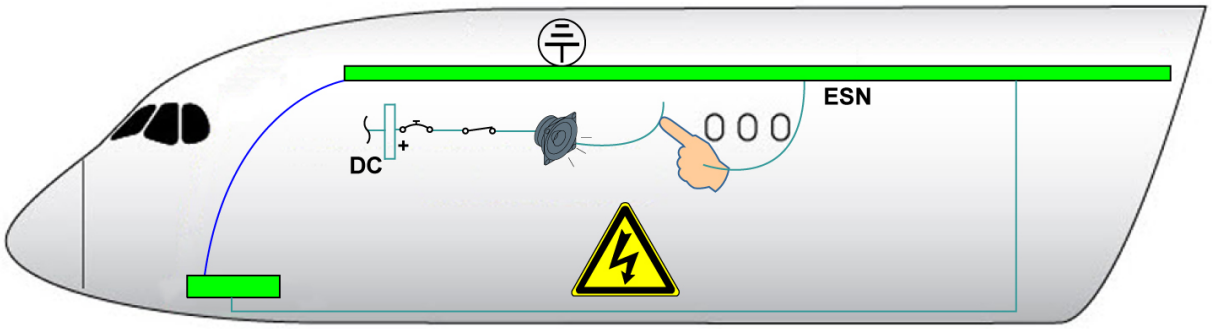


WARNING

ENSURE THAT GROUND CONNECTIONS ARE GOOD.
IF NOT, SYSTEMS MAY BE INOP



GROUNDING

BONDING

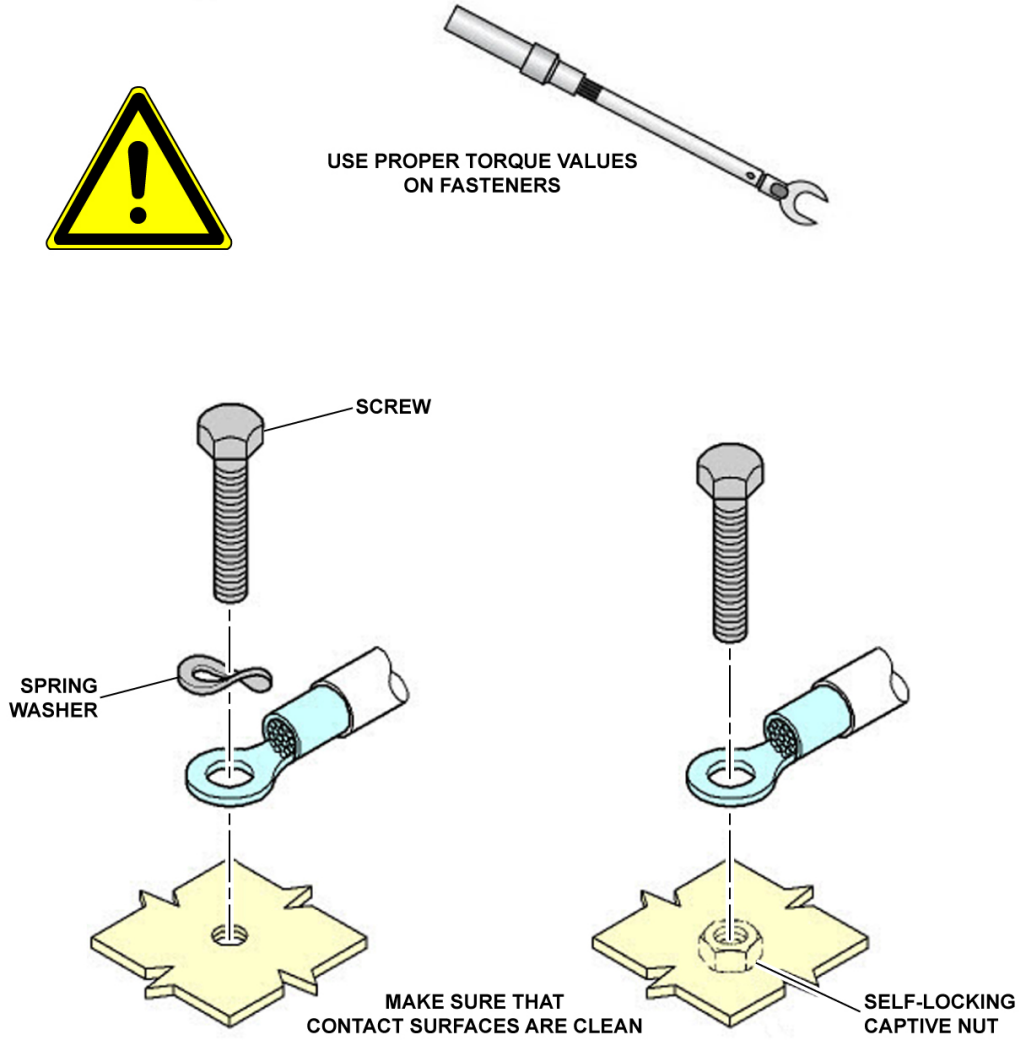
CURRENT FLOW

ESN: Electrical Structure Network
INOP: Inoperative

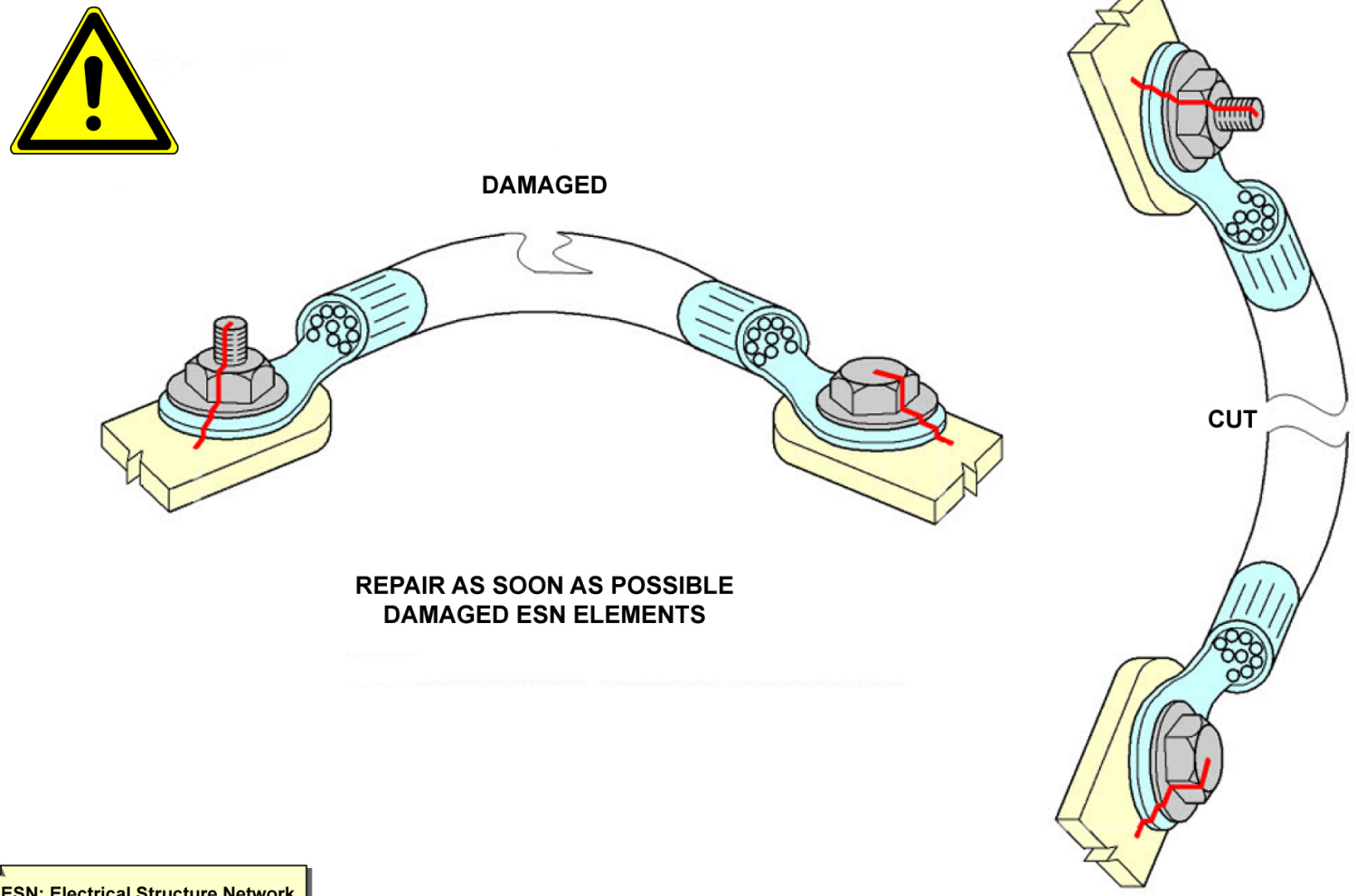
WARNING

ENSURE THAT WIRE CONNECTIONS/ATTACHMENTS
ARE NOT LOOSE. RISK OF ELECTRIC SHOCKS

ESN PRECAUTIONS



ESN PRECAUTIONS



ESN PRECAUTIONS

ELECTRICAL STRUCTURE NETWORK (ESN) AND METALLIC BONDING NETWORK (MBN) AWARENESS (3)

ESN Elements and Views

ESN is composed of different element families, which are:
- Structure metallic elements (e.g. metallic frames, crossbeams, seat tracks, roller tracks, etc.) and their assembly.
- Mechanical elements (e.g. parts supporting equipment such as the electronics bay rack, mechanical junctions, cabin furnishing structures in the crown area) and their assembly.
- Specific ESN components (raceways with flexible junctions all along the fuselage and cables). The flexible junctions provide additional means to either reinforce electrical bonding between main elements (e.g. crossbeam, frames, etc.) or create the electrical continuity (e.g. between two raceways).

Examples of network, elements and flexible junctions are shown in the illustrations.

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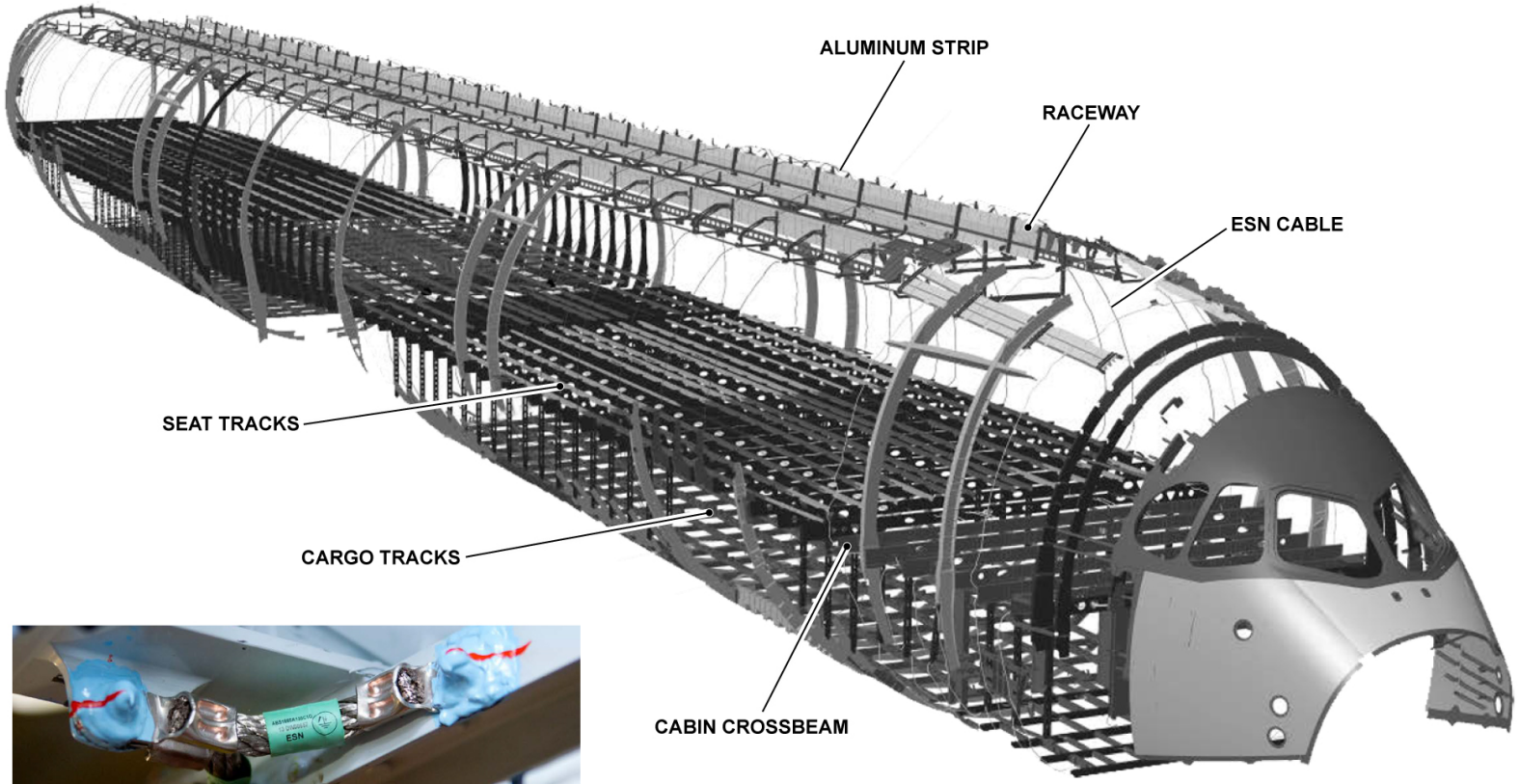
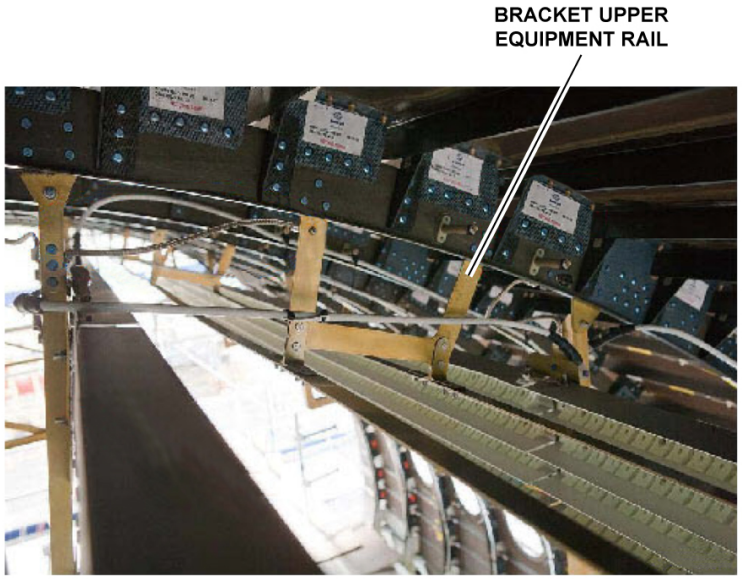
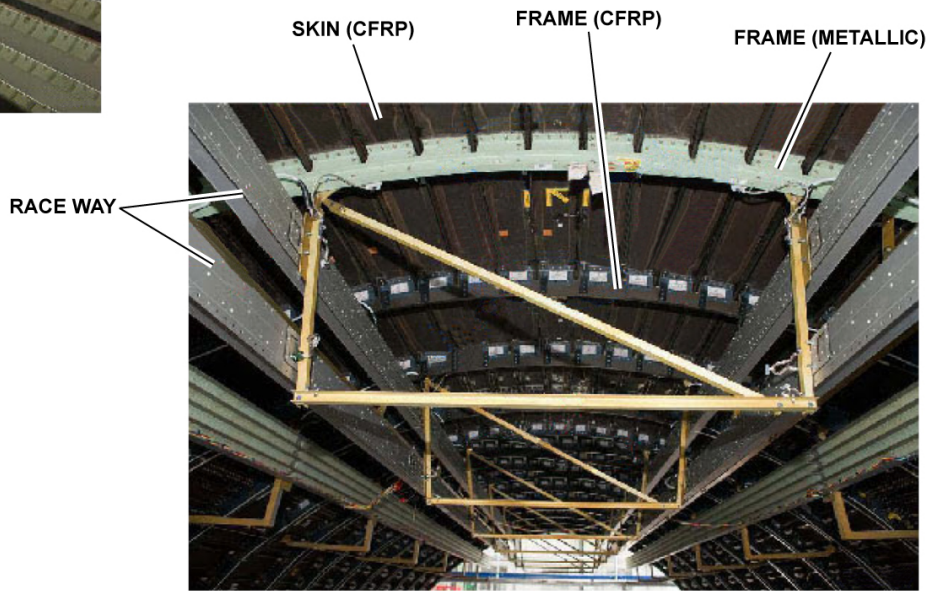


ESN BONDING BRAID
(FLEXIBLE JUNCTION)

ESN: Electrical Structure Network

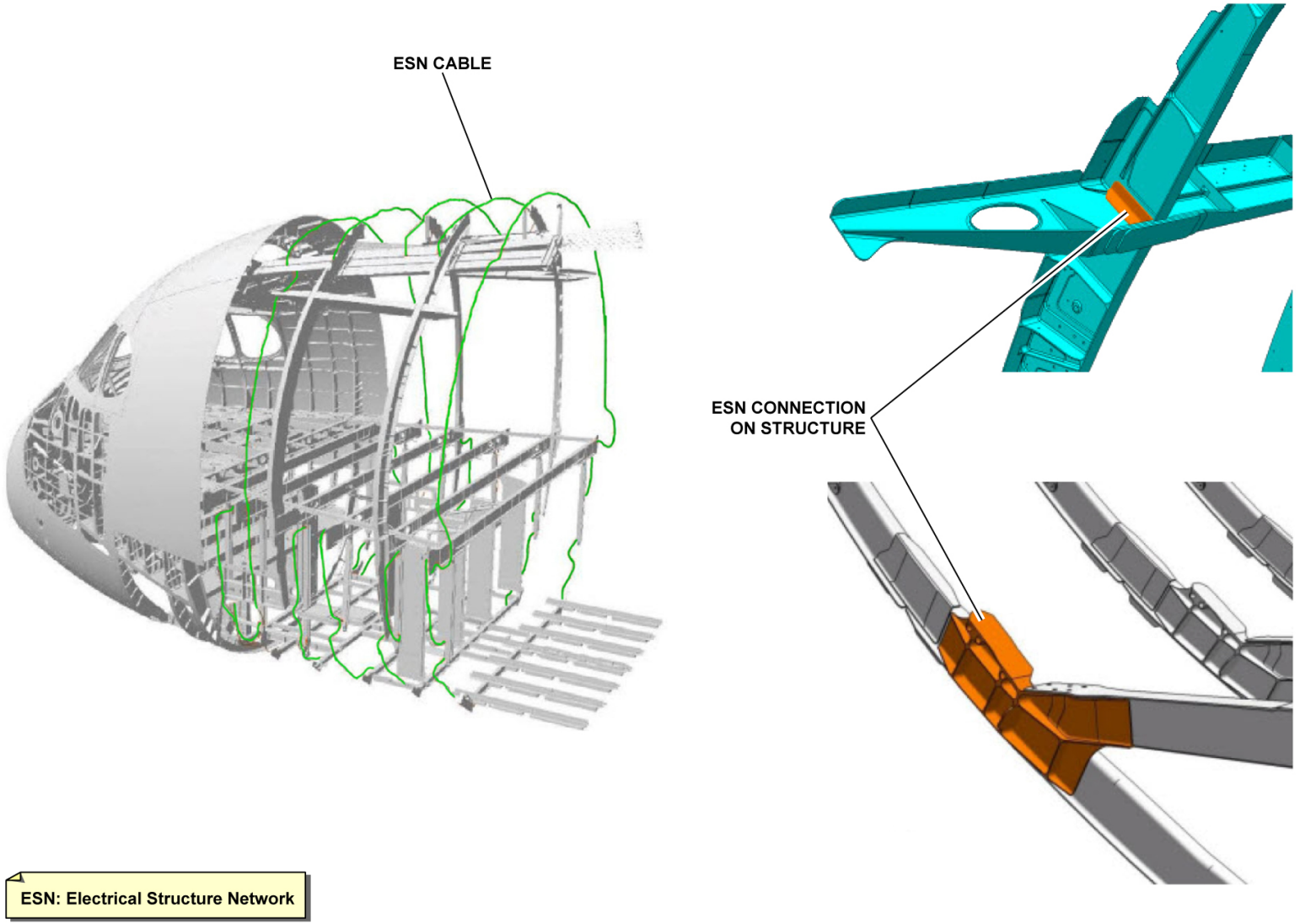
ESN ELEMENTS AND VIEWS



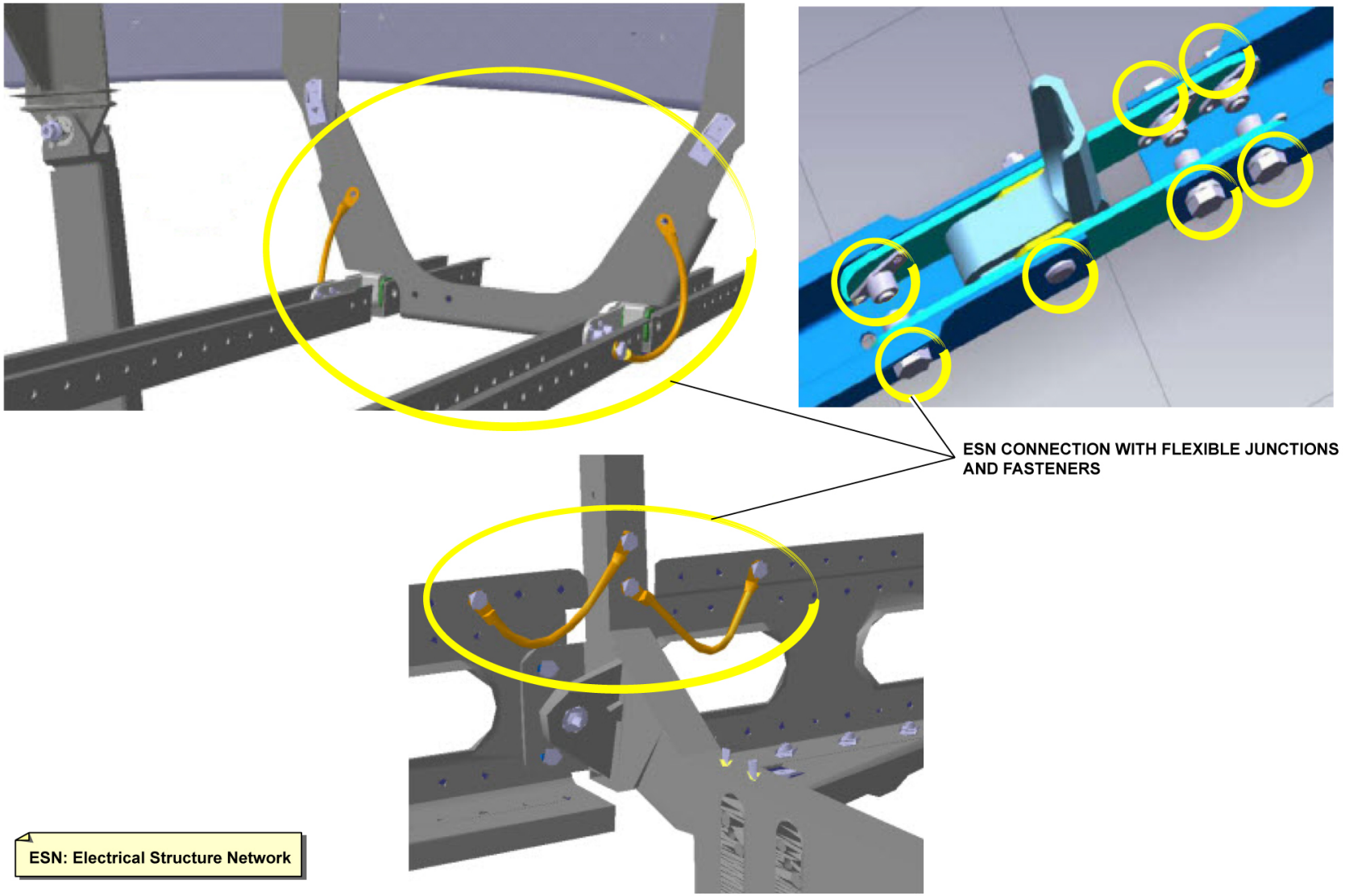


CFRP: Carbon Fiber Reinforced Plastic

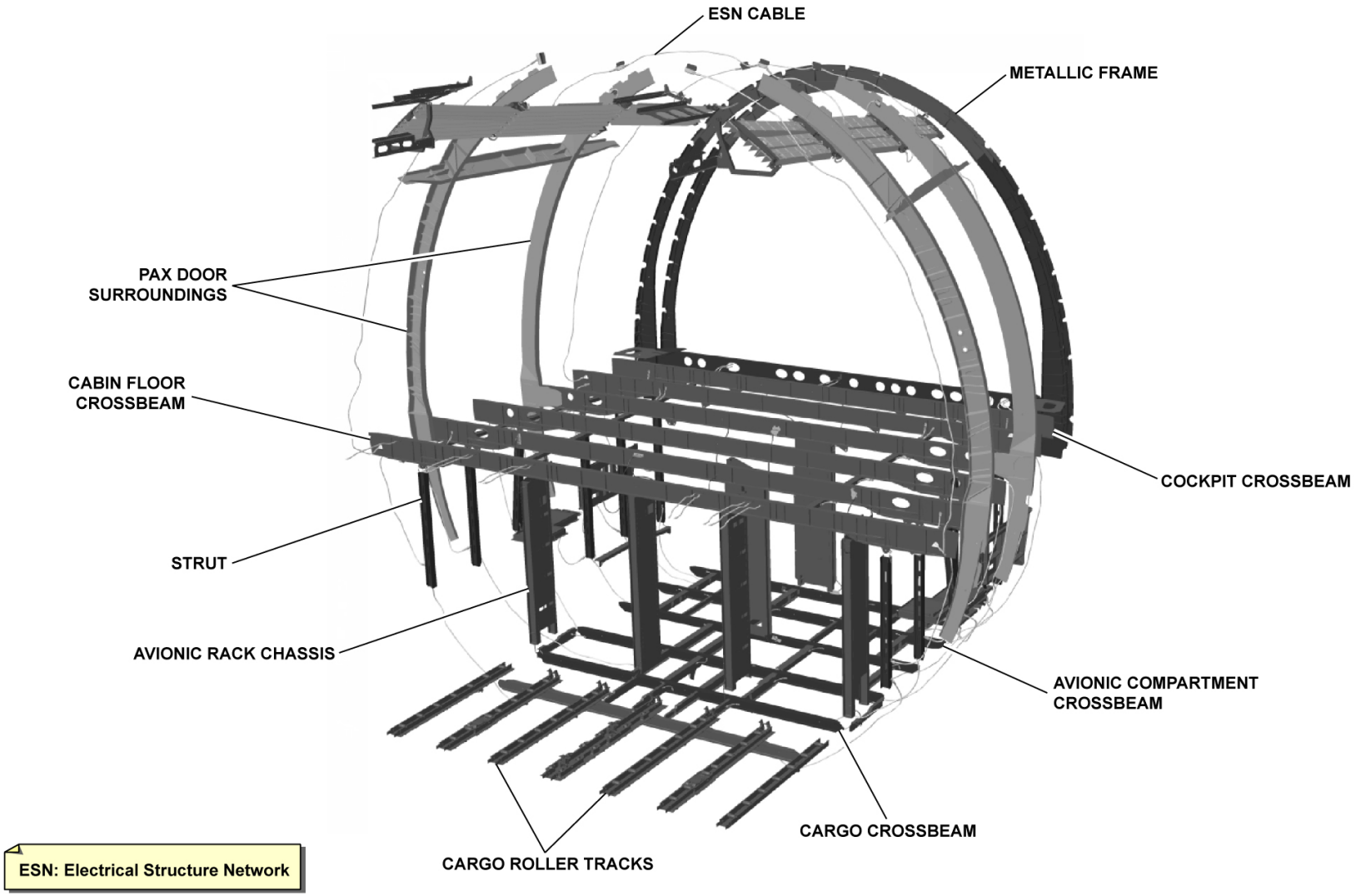
ESN ELEMENTS AND VIEWS



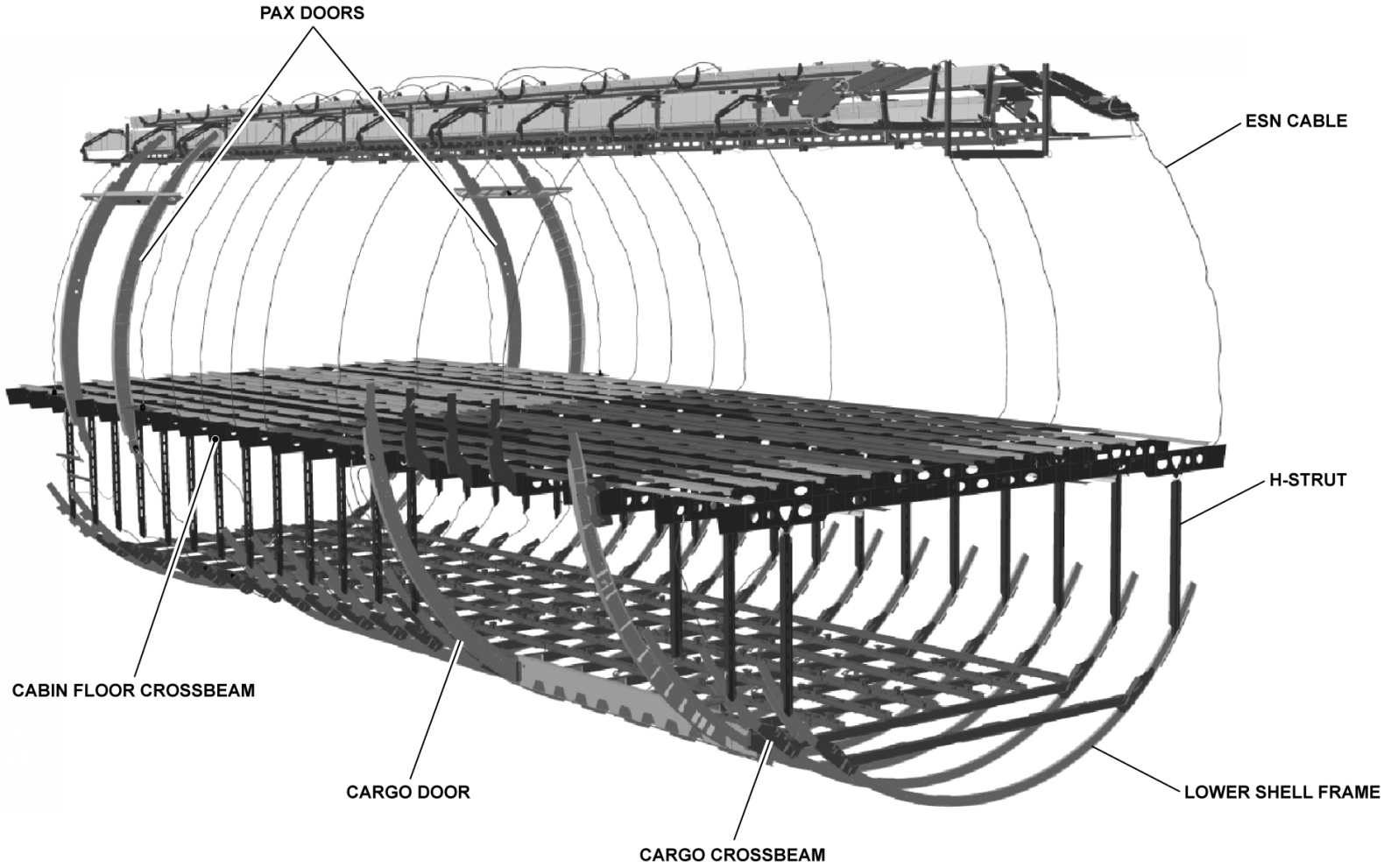
ESN ELEMENTS AND VIEWS



ESN ELEMENTS AND VIEWS



ESN ELEMENTS AND VIEWS



ESN ELEMENTS AND VIEWS

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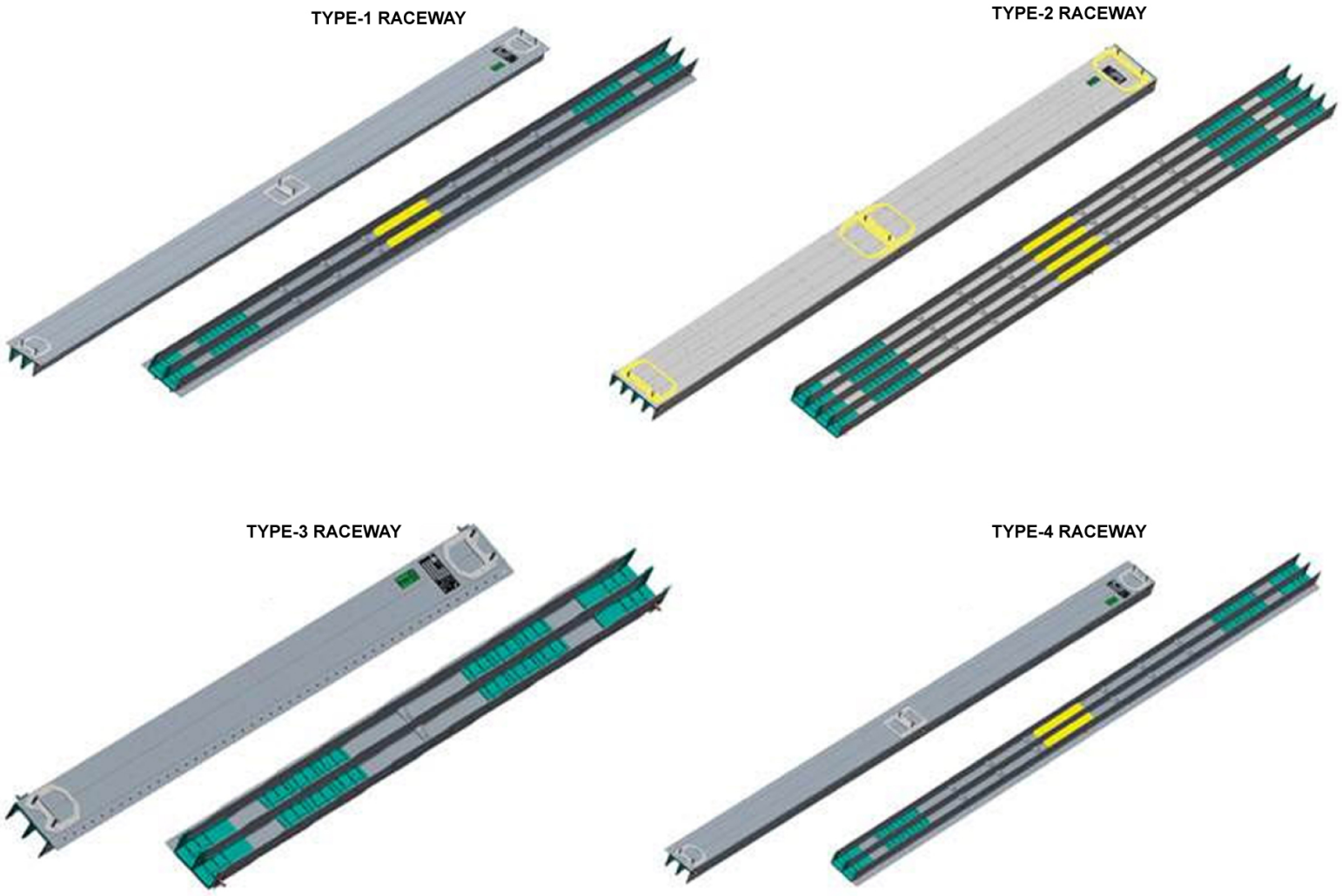
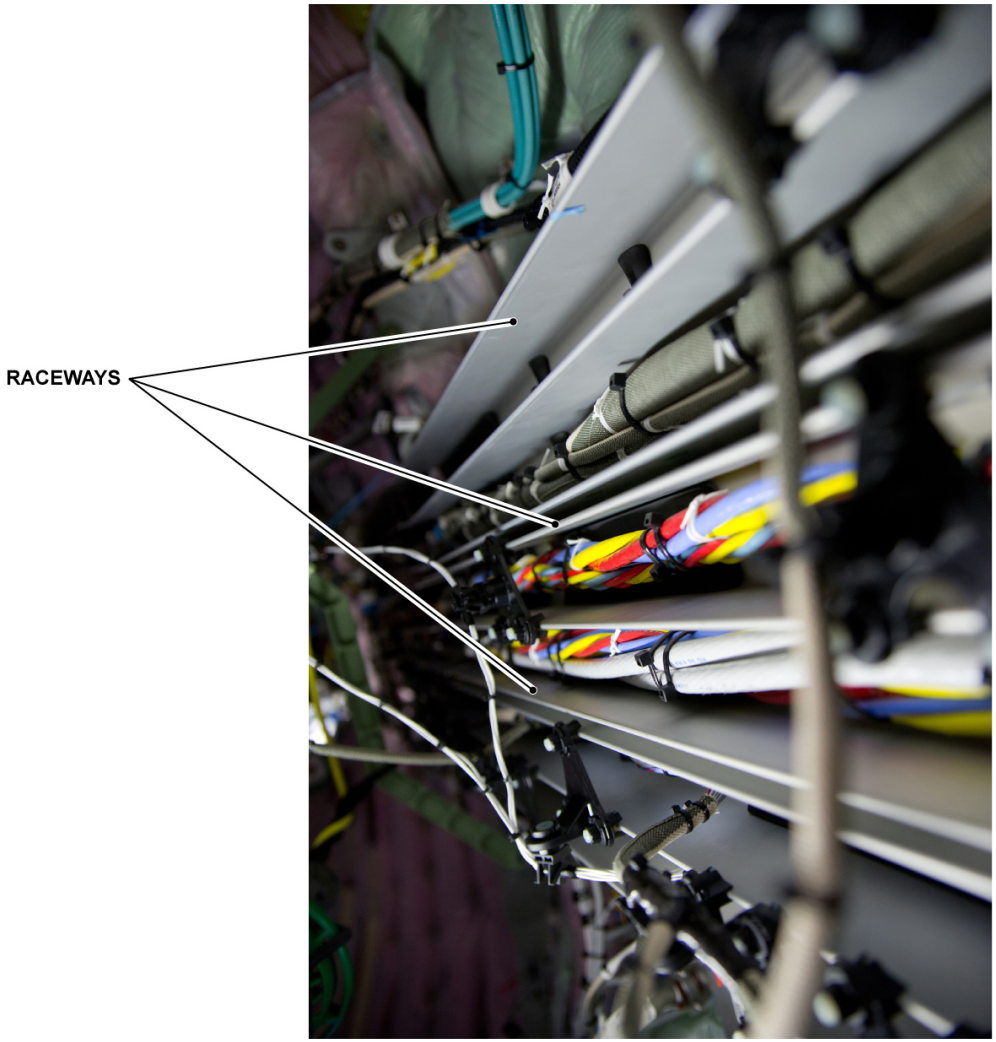
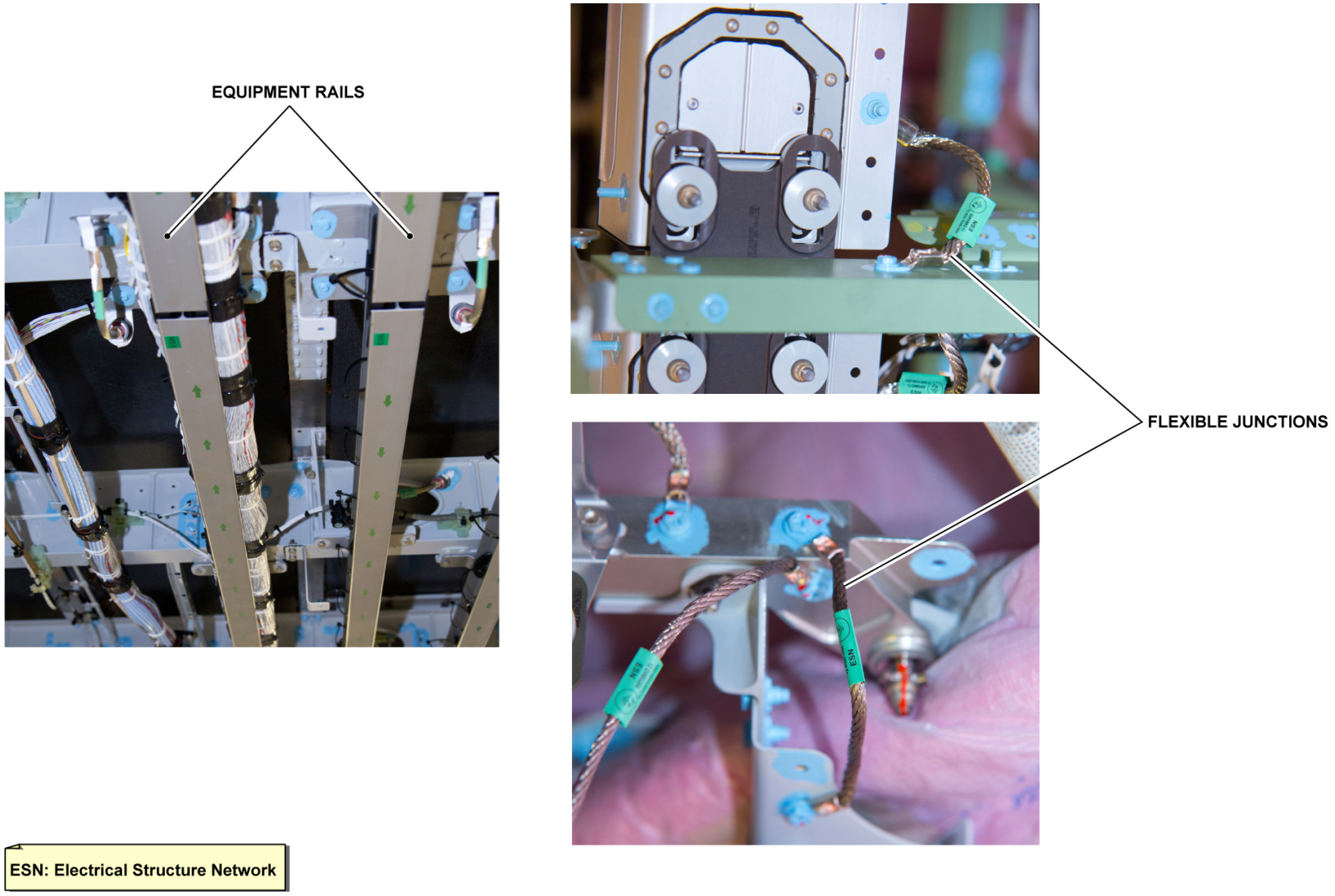


ESN ELEMENTS AND VIEWS

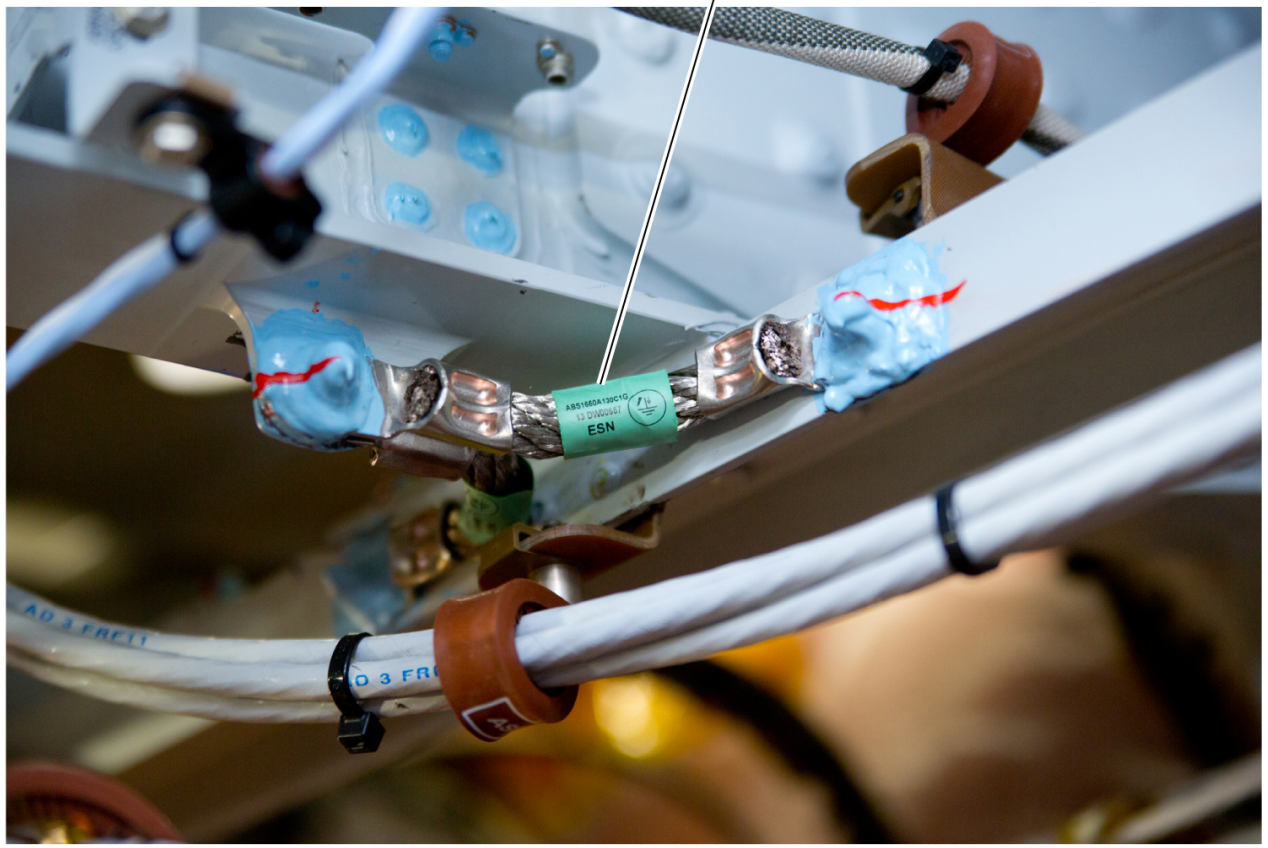


ESN ELEMENTS AND VIEWS



ESN ELEMENTS AND VIEWS

FLEXIBLE JUNCTION WITH ESN IDENTIFICATION SLEEVE



ESN: Electrical Structure Network

ESN ELEMENTS AND VIEWS

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